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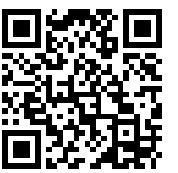

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THE ROYAL ENGINEERS JOURNAL.

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JANUARY TO JUNE, 1919.

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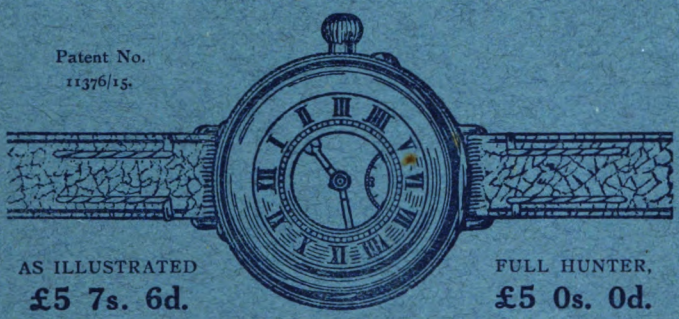

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NOTES ON EXPERIMENTAL APPARATUS FOR SETTING OUT MODELS OF TRENCHES.

By 2ND LIEUT. H. CHURCH, R.E.

THE object of this Experimental Apparatus was to provide a quick and inexpensive means for carrying out the following :—

(*a*). To set out a model of an existing trench system to any given scale.
(*b*). To set out a model of proposed new work.
(*c*). To set out practice trenches for Infantry practice attacks.
(*d*). To set out on the ground a defence line in a rear position. (The use of the apparatus for this purpose is subject to restrictions depending on the nature of the ground.)

The above are referred to in various official pamphlets and the proposal of supplying the Infantry with a model of the trenches they are to occupy is admitted to be the quickest and surest method of supplying them with the necessary information.

The method involves making one lineal measurement only. The relative positions of all points being determined by setting out angles direct from the map. In cases of extreme urgency, when a definite map does not exist, an aeroplane photograph can be used provided the distance apart of any two recognizable points on the photograph is known. When using an aeroplane photograph the resultant model, would not of course, be so accurate as when a proper map is used.

The method depends on the similarity of triangles. Great accuracy is not required, but a very fair degree of accuracy can be obtained. For example :—With fairly rough apparatus a model was constructed on the ground which was correct to within 1 per cent. The whole idea is to produce a model as quickly as possible.

Five men are required and if trained the whole operation resolves itself into a series of very simple operations which are rapidly carried out.

The apparatus consists of :—

(1). Two tables, A and B (see sketches) mounted on tripods and provided with sight arms.
(2). Two pairs of sighting rods, CE and DF.
(3). Two Field Telephones and electric cable. (Only required when the base exceeds 100 yards.)

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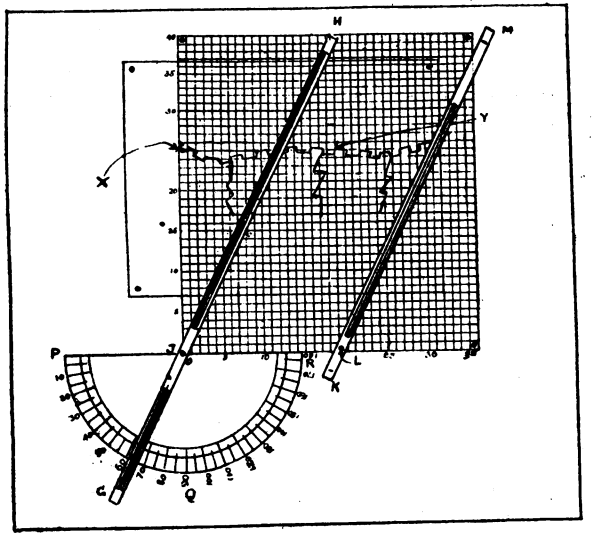


TABLE B.

Scale=One-Eighth full size.

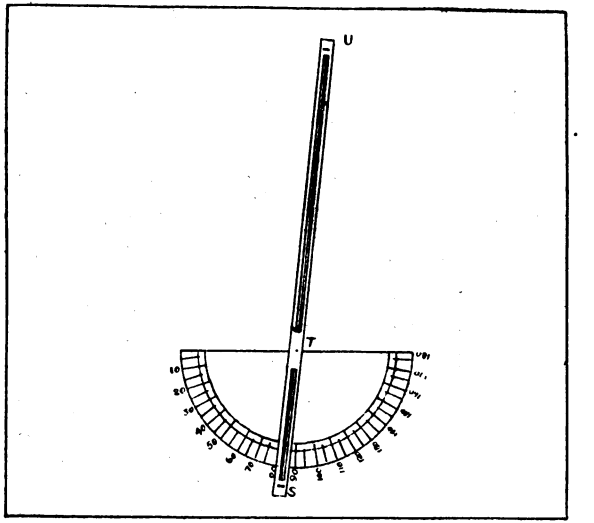
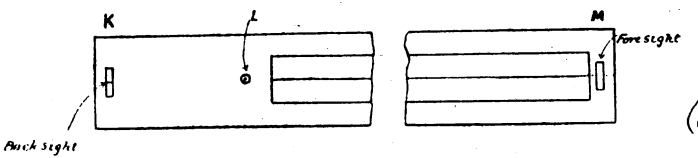


TABLE A.



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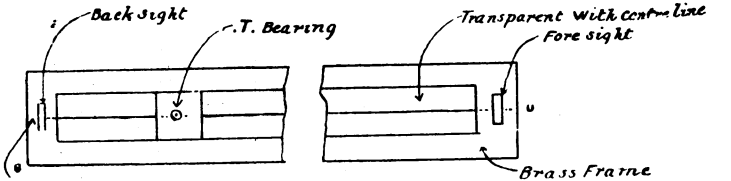

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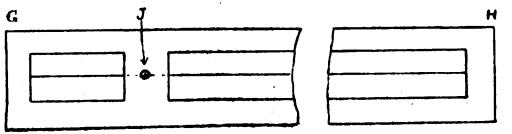

— Sight Vanes not drawn to scale —

SKETCH NO. 1.

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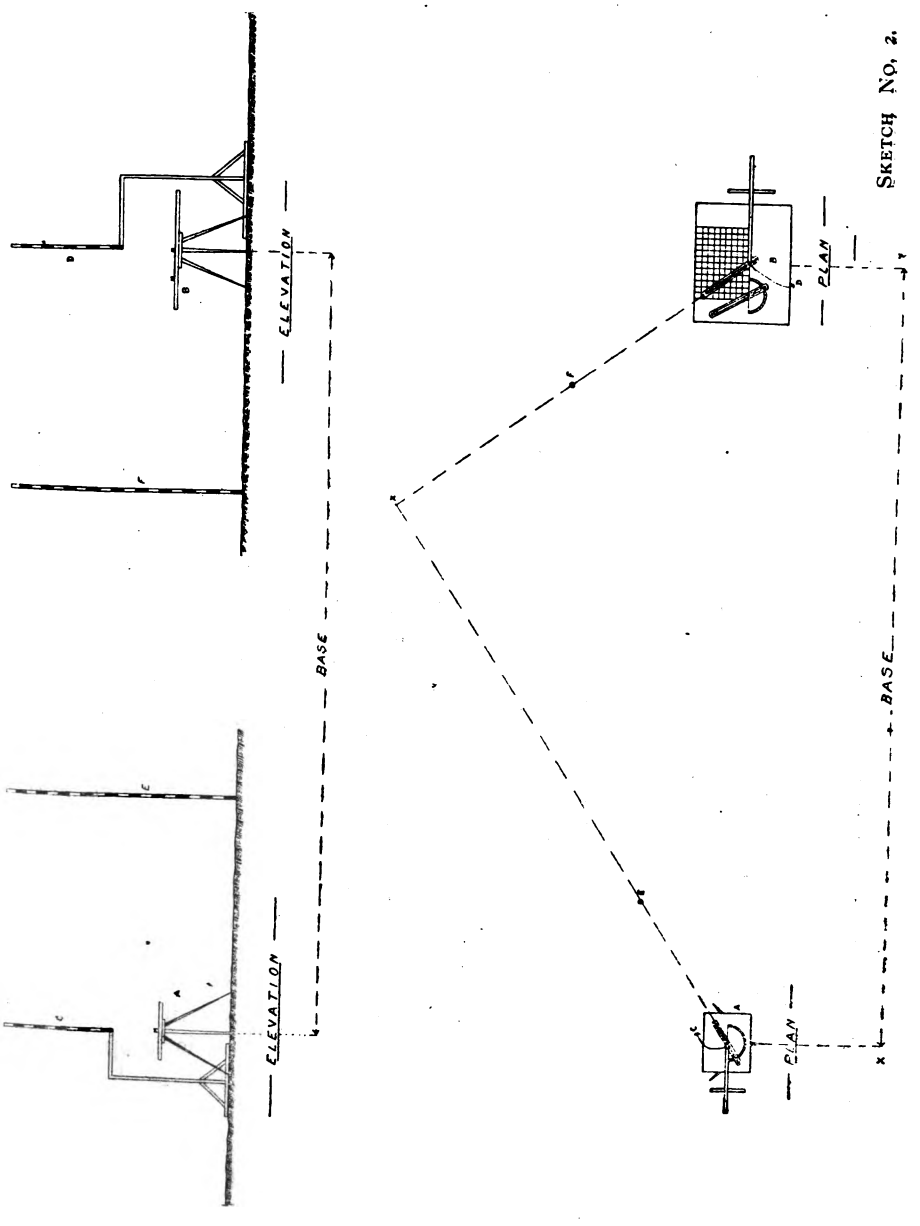

SKETCH No. 2.

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Method of Use.—Assume that the apparatus is required for "*a*" referred to above.

A map is provided and a tracing made of the part under consideration. The table B has on it a number of horizontal and vertical lines marked 0—40 (or other convenient number), and a degree scale as shown. The map of the trench system is pinned to the table (as indicated), in such a way that a point X is on the vertical line marked O and a point Y is on the horizontal line through X. The points X and Y are a known distance apart on the ground. Assume this to be 400 yards. GJH is a degree arm, pivotted at J and arranged so that the angle subtended by any point on the map to the base JL is read directly on the degree scale PQR. KLM is a sight arm, but no degree scale is provided and the pivot L is adjustable and its position is adjusted until JL is equal to XY on the map. The table A is provided with a sight arm STU and degree scale so that the position of GJH can be reproduced on A. Now assume that a model is to be set out representing the trenches between X, Y, to a scale of 1/10. The procedure is as follows:—Table B is set up on the ground with a sighting rod D, the latter being vertically above the pivot L (see sketch 2). Table A is set up 40 yards from B, with sighting rod C vertically above the point T. Tables A and B are lined up by means of the sight arms. A and B are connected by telephone if over a hundred yards apart. The apparatus is now in position ready to set out the model.

To fix the point X on the ground:—

Two operators work at A and B respectively. The man at B takes control. He sets GJH over X on the map and reads the angle on degree scale, which he telephones to A who sets STU to the same angle. GJH is then moved to the left and KLM is set over X. Two other men take the sighting rods and place them about 20 yards from A and B in line with the sights on STU and KLM. The operators at A and B shout orders to the men at E and F until the correct positions are obtained. A fifth man at X (on the ground) adjusts his own position until he is in line with CE and FD. He then puts a picket in the ground thus marking the position of X. A similar method is adopted for all other points and the result will be a model to the scale of 1/10th. In practice it is found convenient to number all important points on the map and to read off all the angles for the operator at A before commencing to set out. The operator at A then has a list of points and corresponding angles. A and B set their sight vanes for point No. 1, and the fifth man signals when he has marked the position. A and B immediately re-set for No. 2 point and the fifth man marks the position, and so on until all points have been marked on the ground.

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The rule for determining the length of base, *i.e.*, the distance apart of the two tripods A and B is :—

$$\text{Length of base in yards} = \text{Distance on ground between X and Y} \times \frac{1}{N}$$

where $\frac{1}{N}$ = the scale of the model required.

Setting out Contours.—The method of setting out contours is obvious. A number of points are taken on each contour and these are then set out on the ground, the pickets used being of such a size as to correspond to the particular contour concerned. That is :—Contour marked 30 ft. can be represented by 3-ft. pickets. The tops of all pickets on one contour are joined by a string. The same is done with other contour lines and earth placed on the ground up to the strings.

General.—It is suggested that squads of one N.C.O. and five men, with an Officer in charge of several squads, could move quickly from place to place and in a very few hours tape out models near the troops concerned. Such squads to be attached to Field Survey Cos. and not to form a new unit.

Results of Practical Experiments.—(1). The apparatus used consisted entirely of cardboard models mounted on two barrack tables and was made without the use of any special tools.

(2). At 9 a.m. a model of 570 yards of fire trench (ours and enemy position) was commenced. The resultant model to be 1/10th full size. Before commencing to set out, a tracing had been made of the angles measured for the operator at A.

Time taken to place all pickets in position ...	½ hour.
,, tape in	1¼ hours.

In the above a double line of tape was used to show fire trench, single tape to show communication trench and a double tape with diagonals at about every 6 ft. to represent wire. Contours not shown.

(3). At 12 noon an order was received to construct the above in another field situated about two miles away. The apparatus was shifted, placed in position, and a model produced to the scale of 1/10th by 3.30 p.m.

(4). The party engaged on the above consisted of one officer, one sergeant, and four sappers, exclusive of transport. (Transport was only required because experimental apparatus was mounted on barrack tables and not on tripods).

(5). The above experiment demonstrates the rapid use of the apparatus.

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DEMOLITIONS UNDER FIRE.

By T.E.L.

WE were interested in the Hejaz Railway, and spent nearly two years on it. The Turkish counter-measures were passive. They garrisoned each station (an average of 14 miles apart) with half a company, entrenched, sometimes with guns, and put in between the stations a chain of small entrenched posts, usually about 2,000 yards apart, and sited on small knolls or spurs within 200 yards of the railway, so that each post could see its neighbours and command all the intermediate line. Extra posts were put on one or other bank of any large bridge. The 15 or 20 men in the post had to patrol their section of line after dawn each day, and in the afternoon. There was no night activity on their part.

The Turks arrived at their system of defence after considerable experience of our demolition parties, but we were able, till the end of the war, to descend upon the railway when and where we pleased, and effect the damage we wished, without great difficulty. At the same time our ways and means had constantly to be improved. We began with small parties of ten or fifteen Beduins, and we ended with mobile columns of all arms, including armoured cars; nevertheless I believe that it is impossible for a purely passive defence, such as the Turkish, to prevent a daily interruption of the railway traffic by a decently equipped enemy. Railway defence, to be inviolable, would require a passive force, entrenched with continuous barbed wire fence, and day and night patrol, at a considerable distance from the line, on each side of it; mobile forces, in concentrations not more than 20 miles apart; and liberal air reconnaissance.

The actual methods of demolition we used are perhaps more interesting than our manners of attack. Our explosives were mainly blasting gelatine and guncotton. Of the two we infinitely preferred the former when we could get it. It is rather more powerful in open charges in direct contact, far better for indirect work, has a value of 5 to 1 in super-tamped charges, is quicker to use, and more compact. We used to strip its paper covering, and handle it in sandbags of 50 lbs. weight. These sweated vigorously in the summer heats of Arabia, but did us no harm, beyond the usual headache, from which we never acquired immunity. The impact of a bullet may detonate a sack of it but we found in practice that when running you clasp it to your side, and if it is held on that furthest from the enemy, then the chances are that it will not be hit, except by the bullet that has

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already inflicted a mortal wound on the bearer. Guncotton is a good explosive, but inferior in the above respects to gelatine, and in addition, we used to receive it packed 16 slabs (of 15 oz. each) in a wooden box of such massive construction that it was nearly impossible to open peacefully. You can break these boxes with an entrenching tool, in about four minutes slashing, but the best thing is to dash the box, by one of its rope or wire beckets against a rock until it splits. The lid of the box is fastened by six screws, but even if there is time to undo all of these, the slabs will not come out, since they are unshakably wedged against the four sides. I have opened boxes by detonating a primer on one corner, but regard this way as unnecessarily noisy wasteful and dangerous for daily use.

Rail Demolition.—Guncotton in 15-ounce slabs is convenient for rail cutting. The usual method of putting a fused and detonated and primed slab against the web is quick and easy, but ineffective. The slab cuts a six-in. section out of the lie, leaving two clean fractured surfaces (Hejaz rails are of a mild Maryland or Cockerill steel). The steel chairs and sleepers are strong, and the enemy used to tap the broken rails again into contact with a sledge, and lay in a new piece whenever the combined fractures were important enough. New rails were ten metres long, but the line worked well on unbolted pieces two or three metres long. Two bolts are enough for a fish plate, and on straights the line will serve slow trains for a mile or two without fish plates, owing to the excellence of the chairs. For curves the Turks, after we had exhausted their curved rails, used short straights. These proved efficient even on 120-metre curves. The rate of repair of a gang 100 strong, in simple demolition is about 250 cuts an hour. A demolition gang of 20 would do about 600 cuts an hour.

A better demolition is to lay two successive slabs on the ballast beneath the bottom flange under the joint and fish plate, in contact with the line. This spoils the fish plate and bolts, and shortens each of two rails by a few inches, for the expenditure of two slabs and one fuse. It takes longer to lay than the simple demolition, but also takes longer to repair, since one or other rail is often not cut, but bent, and in that case the repair party has either to cut it, or to press it straight.

The best demolition we discovered was to dig down in the ballast beside a mid-rail sleeper between the tracks, until the inside of the sleeper (iron of course) could be cleared of ballast, and to lay two slabs in the bottom of the hole, under the sleeper, but not in contact with it. The excavated ballast should then be returned and the end of the fuse left visible over the sleeper for the lighting party. The expansion of air raises the middle of the sleeper 18 in. from the ground, humps the two rails 3 in. from the horizontal, draws them 6 in. nearer together, and warps them from the vertical inwards by the

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twisting pull of the chairs on the bottom outer flange. A trough is also driven a foot or more deep across the formation. This gives two rails destroyed, one sleeper or two, and the grading, for two slabs and one fuse. The repair party has either to throw away the entire track, or cut a metre out of each rail and re-grade. A gang of 100 will mend about 20 pairs an hour, and a gang of 40 will lay 80 an hour. The appearance of a piece of rail treated by this method is most beautiful, for the sleepers rise up in all manner of varied forms, like the early buds of tulips.

Simple demolitions can be lit with a 12-in. fuse. The fish-plate-flange type should be lit with 30-in. fuses, since the fragments of steel spray the whole earth. The "tulips" may be lit with a 10-in. fuse, for they only scatter ballast. If however, the slabs have been allowed to get into contact with the metal of the sleeper they will throw large lumps of it about. With a 10-in. fuse most of these will pass over the head of the lighting man who will be only 15 yards or so away when it goes off. To be further is dangerous. We were provided with Bickford fuse by Ordnance. The shiny black variety causes many accidents, owing to its habits of accelerating or smouldering. The dull black is better, and the white very good. Our instantaneous fuse has an amusing effect if lit at night among friendly tents, since it jumps about and bangs; but it is not good for service conditions. The French instantaneous fuse is reliable. Detonators should always be crimped on to ready-cut fuses, and may be safely carried in the pocket or sandbag, since great violence is required to set them off. We generally used fusees for lighting.

Speaking as a rule rail demolitions are wasteful and ineffective unless the enemy is short of metal or unless they are only made adjuncts to bridge-breaking.

A pleasant demolition, of a hybrid type, is to cut both rails, and turn them over, so as to throw them on their face down the bank. It takes 30 men to start this, but a small gang can then pass up the line, bearing on the overturned part, and the spring of the rails will carry on the reversing process, until you have done miles of it. This is an effective demolition with steel sleepers, since you wreck the ballasting. We tried it once on about 8 miles of a branch line, with a preponderance of spiked wooden sleepers, and it made such a mess of rails and sleepers that the Turks washed their hands of it.

The Hejaz line carried a minimum of traffic, so that there was no special virtue in destroying the points of crossing places.

Bridge Demolitions.—The lightness of traffic affected the tactics of bridge demolition also, since a single break was met either by transport or deviation. As with the rails however, the methods we used are perhaps more important than why we did it. Most of the bridges are of dressed limestone masonry, in 80 to 100-pound blocks, set in lime mortar. The average spans were from four to seven metres, and

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the piers were usually 15 ft. wide and 4 ft. 6 in. thick. It is of course better to shatter a bridge than to blow it sky-high, since you increase your enemy's labours. We found that a charge of 48 pounds of guncotton, laid against the foot of the pier on the ground, untamped, was hardly enough, and that 64 pounds was often a little too much. Our formula was therefore about $\frac{1}{5}BT^2$ for guncotton charges below 100 pounds, untamped. In a pier 15 ft. broad, had the feet been marked off on it, we would have had no explosive between feet 1 and 3 and 12 and 15. The bulk would have been against 4, 5, and 10, 11, with a continuous but weaker band uniting 5 and 10. Dry guncotton is better than wet for such work; gelatine is about 10 per cent. stronger for these open charges. With charges above 100 lbs. $\frac{1}{8}BT^2$ or $\frac{1}{7}BT^2$ is enough. The larger your object the smaller your formula. Under fire, the inside of the bridge is fairly safe, since enemy posts enfilade the line and not the bridge arches. It is however seldom leisurely enough to allow of tamping a pier charge by digging. When it is, a trench a foot deep is all that is possible, and this does not decrease a guncotton charge by more than 10 per cent. Gelatine profits rather more in proportion by simple tamping.

A quick and cheap method of bringing down the ordinary pier or abutment is by inserting small charges in the drainage holes that are usually present. In the Hejaz line these were in the splay of the arch, and a charge of 5 lbs. of gelatine, or 25 of guncotton, in these would wreck the whole line. The depth and small size of the drainage holes tamp the explosive to an extreme degree. Where the bridge was of many spans we used to charge alternate drainage holes on either side. In the ordinary English abutment where the drainage holes are small and frequent, it would be wise to explode several simultaneously by electricity, since the effect is much greater than by independent firing. Necklacing and digging down from the crown or roadbed are methods too clumsy and slow for active service conditions.

In North Syria, where we came to bridges of great blocks of basalt, with cement joints, we had to increase our charges for untamped work to $\frac{1}{4}$ or even $\frac{1}{3}BT^2$.

We found guncotton most convenient to handle when we knotted it up into 30-slab blocks by passing cords through the round holes in the middle of the slabs. These large bricks are quick to lay and easy to carry. An armoured car is very useful in bridge demolition, to hold the explosive and the artist. We found in practice that from 30 to 40 seconds was time enough to lay a pier demolition charge, and that only one man was necessary. We usually used 2-ft. fuses.

Girder bridges are more difficult. In lattice bridges where the tension girder is below the roadway, it is best to cut both compression beams. If the tension girder is overhead, it is better to cut both tensions and one compression. It is impossible to do a bridge of this sort

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very quickly. We had not many cases, but they took ten minutes or more each. When possible we used to wedge the gelatine in the angles of meeting girders. The only quick way is to lay an enormous single charge on the top of the abutment and root it all away with the holdfasts. This may require 1,000 lbs. of gelignite, or more, and a multiplicity of porters complicates things. I never blew up a plate girder.

Mining trains pertains perhaps more to operations than to engineering, and is, any way, a special study in itself. Automatic mines, to work on rail deflection always sounded better than they proved. They require very careful laying and to be efficient have to be four-charge compound. This involves electrical connection. The best mine action we had was made for us by Colonel R. E. M. Russell, R.E. and we were about to give it extended use when the enemy caved in.

The ordinary mine was fired electrically by an observer. It is an infallible but very difficult way of destroying hostile rolling stock, and we made great profit from it. Our standard charge was 50 lbs. of gelatine. Guncotton is very little use.

However mining is too large a subject to treat of. The army electrical gear is good, but the exploder seems needlessly heavy. By using a single strand insulated wire (commercial) we fired four detonators in parallel at 500 metres; army multiple-stranded insulated cables will fire two at 500 metres. In series I have never had occasion to fire more than 25 detonators (at 250 yards), but I see no reason why this number should not be greatly increased. The army electric detonators never failed us. A meter test might show that some of them were defective, but even the defective ones will fire on an exploder. It is usually unnecessary to insulate your joints. The exploder goes out of action quickly if knocked about in a baggage column, or slung on a trotting camel, so I usually carried two as reserve.

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ROADS.

THREE important papers were read at The Institution of Civil Engineers, on the 3rd December, 1918, and we are indebted to the Institution for the following abstracts :—

ROAD CORRUGATION.

By ERNEST LEONARD LEEMING, M.Sc. Tech., Assoc. M.Inst.C.E.

The introduction of mechanically propelled vehicles on highways has produced a troublesome and perplexing feature of road wear, namely, corrugation, which, owing to the existing war conditions, when the main roads of this country are heavily trafficked and their maintenance much neglected, has become serious.

The object of this Paper is to state the present position of the problem with regard to road construction and vehicle design, and to indicate probable causes of the trouble, with some suggestions for preventing or alleviating it.

The phenomenon of wave formation or corrugation is met with in most cases of rolling motion on a plane surface. As a general rule, the formation of waves on a road surface is accompanied by longitudinal movement of the road material in the direction of the traffic, and this movement usually depends on the tractive resistance of the particular material ; consequently, water-bound macadam is more likely to become wavy than tar macadam, and so on.

Horse traffic alone may cause waves to develop, but the damage to a road in this respect is only slight compared with that done by motor traffic. The action of the driving-wheels of motor traffic is similar to the pulling action of horses' hoofs, and causes the upper layers of the road material to be moved backwards,—*i.e.*, in the opposite direction to the traffic ; sets, for instance, are tilted backwards. And therefore the combined effect of forward movement as a whole and tilting or backward movement of the surface is to produce ridges and hollows.

The effect of a wheel passing over the hollows of a corrugated surface, or over potholes, is to produce a blow on the opposite side of the hollow, and this is shown to depend upon $\frac{Wv^2l^2}{r^2}$ where W,v,l and r are unsprung weight, speed, width of hollow, and radius of wheel.

It is generally admitted that the road roller will form initial waves

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unless great care is exercised, and that traffic will quickly accentuate them. The Crompton three-axle roller introduces a principle which is of great importance in considering the road wave problem.

The action of a two-axle motor-vehicle may be studied by observing the effect when the front wheels meet with an increased resistance due to a ridge or a pothole. The lead of the body of the vehicle on the front axle is increased and the lead of the back axle on the body is likewise increased, owing to the greater resistance to the driving effort ; in other words, vibration of the vehicle as a whole is set up by the distance between the front and back axles changing with a definite period, according to the type and suspension of the vehicle. The wheel-base appears to have some definite relation to the period of the waves formed, and a long wheel-base assists the springing of the vehicle, and enables it to hold the road at speed when the surface is rough or wavy.

Considerable improvements in the suspension of the heavier motor vehicles are needed, the present practice only allowing of the absorption of shocks vertically, and not in the direction of the reaction of the blow on the road ; in this respect, auxiliary springs, check springs, and shock-absorbers are very useful.

The effect of the differential gear in continuing waves along and across a road cannot be too strongly urged, and it is this feature of motor omnibuses which probably accounts for the rapidity with which they propagate waves. If one wheel leaves the road surface, racing takes place, and impulsive driving in both wheels is set up ; when the wheel returns to the surface of the road it produces a strong grinding effect on the material. The same action takes place when braking the rear wheels, except that the grinding action is in the direction of motion of the vehicle.

An interesting feature of road corrugation is, that it often commences earlier on down gradients and at bends than on straight level lengths of road. In the case of the down gradient, the reasons for rapid wave-development may be stated as follows :—

(*a*). It induces increased speed and vibration.
(*b*). It increases the unsprung weight.
(*c*). Driving action and braking action are greater than on level roads.
(*d*). The road material is subjected to very great pushing stresses in a downhill direction.

The increased wear at bends is due mainly to the action of centrifugal force bringing greater weight on the outer wheels, and to the differential gear assisting racing and grinding action. The camber of a road, also, has some influence on wave formation.

The pitch of the waves is not easily determined from vehicle dimen-

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sions, since it often varies at different points on the same road under similar conditions of traffic. The occurrence of rudimentary waves, together with fully developed waves, is another interesting feature of road corrugation. Generally, the pitch is less when the speed is greater; it is also quite independent of the kind of road material laid down.

With regard to the different classes of roads laid at the present time, set-paved roads are only capable of offering resistance to wave-formation when laid on a concrete foundation. Where sets are laid on a yielding and inelastic foundation, corrugation will be quickly set up and considerable tilting and lateral movement will result from heavy traffic. Moreover, Durax paving and wood blocks do not seem able to resist the destructive forces of modern traffic, and sooner or later waves develop.

It is suggested in this Paper that, wherever possible, sets or blocks should be laid arch-shape, in plan, to oppose the movement caused by traffic in a particular direction, so that the paving may be rendered unyielding both vertically and horizontally.

In the case of macadam and tar macadam roads the former is quite useless where heavy traffic is concerned, and even tar macadam offers no real solution to the problem.

The bituminous road-surface appears to be the most suitable for modern traffic, on account of its great strength, and also its elastic qualities, which go far to compensate for the unsprung weight of vehicles. Further, traction and vibration are reduced to a minimum. The development of waves on a bituminous surface is analogous to the formation of waves in the rolling of hot armour-plate.

It is possible that concrete as a surface, under good conditions, might prove a suitable material, but it has not been sufficiently tried in this country to enable definite conclusions of its wave-resisting qualities to be formed.

The conclusions of the Paper show that unless two-axle vehicles can be provided with reasonably good springing, such as results from the air-cushion of the pneumatic tire, some development in the direction of providing three axles and increasing the number of driving-wheels accordingly, for heavy vehicles, is necessary to alleviate the trouble of road-waves.

INVESTIGATIONS IN THE STRUCTURE OF ROAD SURFACES.

By Francis Wood, M.Inst.C.E.

Prior to the War, the question of the structure of roads was being brought into prominence through the advent of mechanically-propelled vehicles; there can be little doubt, however, that the transport needs of war have brought about a climax and emphasized the

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imperative and urgent need of providing roads with a structure that will (1) ensure a good and even surface, (2) be suited to the traffic, (3) be reasonable in first cost, and (4) be easily and cheaply maintained.

Considerable expenditure has been incurred in the past in providing elaborate foundations, which were in many cases necessary owing to the indifferent character of the surface, but there are many cases in which the strength and cost of this section of the road structures are such as would not have been necessary if the surface had been kept even and regular.

The Author suggests that, provided a homogeneous mass of material is interposed between a stable sub-structure and the wearing surface (also homogeneous), the foundations need not be, in effect, more than 4 ins. in depth, and such a combination will satisfy all traffic which reasonably conforms to the regulations that apply to vehicles in this country. It is common knowledge that no failure of the foundation of newly-laid wood pavements is noticeable until the surface begins to develop hollows through wear; it is then that the foundation of concrete begins to show defects.

An apparatus was designed and attached to the rear part of a motor car which would trace on a moving piece of paper the action of the wheel and the body of the vehicle as it passed a hollow in the pavement 18 ins. long and $1\frac{3}{16}$ ins. deep at a speed of 5 to 7 miles per hour. From the resulting diagram various deductions are made, but the most important is that the vehicle was actually stopped in its progress, thus indicating that the momentum acquired by the load on the wheel had been expended on the side of the hollow. It is evident that a continued series of similar blows would cause a very severe strain to the strongest foundation, and would be proportionately greater from commercial vehicles.

The test over an obstruction of the same height did not stop the progress of the vehicle.

The test emphasizes the importance of "stitch in time" repairs, and also the provision of a wearing surface that will resist the wear to the greatest extent, so that hollows do not quickly develop through wear.

Probably the bituminous type of pavement satisfies this demand better than any other that is known at the present time.

The Paper deals with the two-coat mechanically-mixed or artificial asphalt type, as the cost of this construction is less than of natural asphalt. For average traffic it consists of a wearing surface about 1 in. to $1\frac{1}{4}$ in. deep laid on a 3-in. to 4-in. bituminous base coat.

Experiments proved that the base coat itself could be made to act not only as a base, but also to give the wearing surface, and would wear more economically than water-bound macadam. Disintegration began in the third year; the coat subsequently recovered, but

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disintegration again developed later, and eventually it failed under heavy traffic after about six years. The causes are investigated, and the failure is attributed to the expansion and contraction of the bitumen in combination with the use of large-sized stones.

The conclusion arrived at is, that the surfacing material which is exposed to considerable variations of temperature should not have any particles larger than about $\frac{1}{4}$ in. when used with bitumen.

This points to a justification of the separate wearing surface coat laid on a base which can be made with a composition of large, medium and small-sized stone mixed with a suitably prepared tar.

In regard to the wearing surface coat many different compositions have been laid, and there has been a noticeable proportion of comparative failures. There has been a tendency to attribute these wholly to the bitumen used in the composition. In the Author's view, although the bitumen plays a very important part, it is almost of minor importance compared with the grading of the mineral matter and the distribution of the bitumen.

Calculations are given which consistently indicate that the thickness of the film of bitumen on the surface of the particles of natural and artificial asphalt is such that Nature employs 50 per cent. less than is used in the synthetic asphalt. A Table is given indicating the amount of bitumen required to cover any particular grade of material. From this Table the percentage of bitumen required to coat any specified mixture of grades of material can be readily determined. The Table will be advantageous in helping to ascertain whether the cause of the failure may be attributed to the lack of bitumen.

In the above comparison of natural and artificial asphalt, the percentage of bitumen by weight of analysis is very similar to that of the artificial material. There would be a different result if volumetric analysis had been made. An example is given of two analyses of the same grading of bitumen contents, yet when the specific gravities had been determined, one shows 25 per cent. bitumen less than the other. Hence misleading conclusions may be arrived at unless the whole of the factors are taken into consideration.

In connection with the design of the structure, it must not be assumed that any grading of material can be used, or similarly that the grading should be so arranged as to give a voidless structure. A voidless structure *per se* will not necessarily give a good road structure; in fact a designed voidless structure will give a percentage of voids when in the road, because it is laid when the bitumen is in an expanded state, and as soon as it is cold it contracts and must leave voids. A rolled and tamped surface coating will show about 15 to 20 per cent. voids on the underside of the coat, while at the surface it is free from voids.

Examples are given of aggregates of various sizes to bring about a near approximation to a voidless composition, the amount of bitumen

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that would be necessary to fill the void is calculated, and it is shown that it would not properly coat the surfaces.

Pavements that have proved satisfactory show that the fine particles must predominate. It is probably the case that the bitumen containing what are technically termed colloids (*i.e.*, impalpable material of such fineness that if mixed with water it will not settle out after 20 minutes' quiescence) will be more successful than the bitumen that contains no colloids or their equivalent. Apart from this, the opinion is expressed that in the bituminous wearing surface coat about 40 per cent. of the aggregate should be of 200, 100 and 80 mesh (the larger proportion being 200 mesh), 40 per cent. of 50, 40 and 30 mesh, and 20 per cent. of 10 to ¼ in., and that the film thickness on the surface of the particles should be at least 0.00065 to 0.00070 in.

The Author further indicates that there is no advantage in any particular material that is used as the aggregate, that almost any that is locally obtainable, provided it is in a free state and of suitable grading, may give equal results ; *e.g.*, clinker from a refuse destructor ground to the necessary sizes, grit swept from macadam roads, wood-fibre, etc.

NOTES ON ROAD CONSTRUCTION AND MAINTENANCE.

By THOMAS BOWYER BOWER, Assoc.M.Inst.C.E.

Roads are one of the most important of an army's needs. The improvement of the roads of the United Kingdom is a subject of increasing importance, and experience shows that the possibility of military considerations becoming involved should not be neglected in their design and construction.

The average English roads and by-roads are, as a rule, well made, but to carry military traffic they should be not less than 24 ft., and, if possible, 30 ft. wide.

The roads to France, chiefly constructed under Government supervision, were excellent for the traffic likely to use them.

For civilian traffic in peace time, consisting chiefly of slow carts and light motor cars, they are no doubt adequate, but both construction and material—largely a friable limestone—have proved unsuitable for heavy and fast military traffic. The original good condition of the roads, with favourable weather, delayed the appreciation of this, but after the second winter of hostilities, the road surfaces having become bad, frost got into the foundations, and with further increase of traffic the roads got into a deplorable condition. Material was scarce, and temporary measures had to be adopted.

The commonly accepted view that the excessive amount of mud on the roads of France is due to the metal being forced down to the chalk or other subsoil, which then comes to the surface as mud, is disputed

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by the Author. Excepting the case of *pavé* roads, and roads badly worn in holes, he is of opinion that no mud rises to the surface by pressure from above. The true cause of mud formation is the poor quality of the material used, viz., limestone of very soft and porous nature, which, by attrition through some inches of depth, forms the mud, while destroying the surface. The only other materials available in France were pit-props, whole or split, brick rubble, and a poor quality of flint gravel.

The Author then describes methods of repairing holes, deep holes being dealt with by " pigstying " with pit-props, filled in with earth and covered with a foundation of soling rock and a coat of macadam.

The Author has reached the conclusion that there is but one way, as now given, of constructing a road fit to stand abnormal traffic for long. Drainage must first be dealt with. No ditch should be nearer the road than 6 ft., the bottom being 1 ft. below road formation. Side drains from road edge to the ditch should be not more than 50 ft. apart. If the road on one side cuts into a hill slope, culverts must be formed under the road leading from one ditch to the other—these, whether of stone slabs or wood, should not be less than 18 ins. square. Side tilted roads draining across the surface are to be avoided. The edge of the road next the falling ground, if wanting from any cause the 6 ft. margin between the road and the ditch, must be securely supported to take the pressure induced by road traffic, which has a tendency to push the edge of the road outwards, causing the road to lose its camber. A method of securing road edges is then described.

Road excavation must be taken out across the whole width to 18 ins. below the finished road-surface, the bottom being curved to conform to the road camber, which may vary between 1 to 12 and 1 to 50, 1 to 25 being a fair average.

It is well to have upon the ground soling rock, seconds and macadam, in advance of excavation, to avoid delays which may expose the foundation to weather influences. Excavation being completed, the bottom is covered with a 2-in. layer of ashes, or clinker ; this, though not essential, is desirable. The soling rock is then packed and rolled as already described for mending holes. Where the soling rock, when set and keyed, is rough it will be well to hand-pack the rock seconds that come next, if only for one stone thick, " throwing in " to make up the desired thickness ; 9 to 12 ins. of soling rock is sufficient. If this is not procurable hard block chalk will serve, though not so good. The "seconds" should be from 4 ins. to 6 ins. thick, as also the macadam finish. Each layer should be rolled as completed.

This makes a good road easily maintained, and serviceable even when the macadam is worn away.

Corduroy roads are possible only in a well-wooded country, and last but a short time unless well covered with metalling, without

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which the foundation soon becomes wet and soft, with consequent disturbance of the timbers.

To construct a good corduroy road attention must first be given to drainage and excavation carried out as for metalled roads, when "beds" to receive the longitudinal stringers should be excavated, one on each road edge and one at the centre, with two intermediate channels, the centre channel being of width sufficient to take two timbers spaced 2 ins. or 3 ins. apart.

When laid the corduroy must be secured by $\frac{1}{8}$-in. diameter wire fastened by staples to each timber. At every 15 ft. it is desirable to drive pickets, to secure the timbers from shifting. On completion the corduroy should promptly be covered with a thin layer of ashes, or dry soil, followed by a layer of seconds and macadam well rolled in.

Some principal faults in road construction are :—Delay in drainage arrangements until late in the work ; careless laying of soling rock on irregularly formed bottom. Packing soling rock on edge with length of stones transverse to road, in which case the stones are liable to tilt forward in the direction of traffic with consequent disturbance of road surface.

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TRANSCRIPT.

CAMP DRAINAGE AND SANITATION.

By W. H. BESWICK, Assoc.M.Inst.C.E., Assistant Sanitary Engineer, Salisbury Plain Command.

THE following paper, which was read at Swindon Sessional Meeting, July 13th, 1918, is reproduced from *The Journal of the Royal Sanitary Institute*, Vol. XXXIX., No. 2, October, 1918, by the courtesy of the Committee of the Institute.

Camp drainage and sanitation comprise many variations from ordinary municipal practice. For the civil engineer it is quite a new experience, or, rather, adapting experience to new conditions; and previous to the outbreak of war Royal Engineers had no doubt mainly considered the subject from the summer-camp point of view, with the exception of Bulford, Tidworth, and others, which latter camps or barracks were carried out in peaceful times when rapidity of construction was not so essential, and well thought out schemes were first prepared. The problem of new camp drainage became more difficult from the fact that construction and scheme had to proceed at the same time, not scheme first and construction afterwards, but the reverse: as one General put it to the author, "Do the work first and make the plan afterwards!"

The author was engaged by Messrs. John Jackson, Limited, to take charge of the drainage of the Salisbury Plain Camps, comprised in their agreement with the War Office, and he arrived at Bulford on the 12th of October, 1914, to find that drainage was urgently required to enable the camps then under construction to be ready for occupation before the approaching winter.

At this time no general scheme for dealing with camp drainage had been issued from the War Office; and, apparently, individual contractors or agents devised schemes most suitable to the camps they had under construction. In November, however, a memorandum was received, issued by the sanitary adviser to the War Office, setting out simple requirements for settlement tanks and land irrigation. These instructions read:

"Small settling tanks should be constructed of a content equal to about one-tenth to one-fifteenth of the daily flow—the smaller proportion being for the larger volume."

(This is equal to 2.4 or 1.6 hours' flow).

A camp may consist of one or more units having the same or similar

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characteristics, and the Salisbury Plain camps with which the author is most closely associated comprise the following :—

Sling Plantation (adjoining Bulford), 10 units (originally 11).

Larkhill (including Durrington and Rollestone), 40 units originally 60).

Perham Down, 8 units.

Parkhouse, 4 units.

All the foregoing camps were under construction, and all required drainage. At first it was only considered necessary to provide drainage for ablutions, bathrooms and cookhouses, with provision for floor washings and slop water from concrete areas, etc. Urine was not to be taken into the drainage system ; and all latrines were on the pail system, the contents of which, as well as urine, were to be incinerated. Water supplies were then under construction or being considered, mostly by pumping schemes, so the question of daily allowance was important, and it was decided to make provision in drainage schemes for daily supplies not exceeding ten gallons per head.

No rain or surface water is provided for, as in most units this was afterwards dealt with separately in open gutters, etc.

For purposes of outfall sewers and works units had to be grouped, and in the camps under consideration this grouping worked out as follows :—

Sling Plantation to one outfall (Bulford hospital being drained into the existing system).

Larkhill, Durrington, and Rollestone, twelve outfalls varying from 1 unit to 16).

Perham Down, originally six outfalls, now five.

Parkhouse, one outfall.

In accordance with the memorandum from the sanitary adviser to the War Office, a typical drawing for outfall tank for one unit equal to 1/10th the D.W.F. was prepared and issued to the various camps, these tanks being increased in number, and built in parallel to provide for the requirements of two or more units ; those for Sling comprised five tanks. These were so arranged that sludge could be run off to sludge pits from any tank as occasion arose ; neither screening nor grit chambers were provided.

It was soon found that these tanks were too small ; in the case of Sling Plantation complete new works had to be designed, in which the existing five tanks were utilized as screening and grit chambers. In several installations, however, these small tanks are still in action after three years, and giving fairly satisfactory results, although requiring more regular and constant attention.

With a view to simplicity in working, more particularly as it was thought that complicated works would be neglected if left to the care of constantly changing troops, a design for tanks in duplicate was prepared.

The sewage first passes into a screening chamber common to both tanks, then through a screen and, by submerged inlets, into the tanks, which have steep, inverted pyramid bottoms. The effluent is drawn off over a full width weir, first passing under a scum board. The screening chamber is also an inverted pyramid with a sludge valve at the bottom, while from the tanks sludge pipes are carried to a valve chamber leading

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to the sludge lagoon, (the sludge being removed by hydraulic head), about 3 ft. head being found very effective. The screening chamber and tanks form two ponds, with a difference of from 2 ft. 3 ins. in water-level, so that solids passing into the inlet channels are carried through the inlets to the tanks with an increased velocity, the effect of the continuous weir outlet being to prevent currents, and, at the same time, discharging the effluent in a thin film.

These tanks are found to answer excellently well for slop-water drainage, but where a water-carried system of drainage is installed, some modification of the screening and grit chamber is required to provide a flow through the screen so that the fæcal matter will be carried forward into the tanks.

In November, 1915, the author was transferred to the Royal Engineers, and has been employed since then in completing works designed by him for Messrs. John Jackson, Limited, and carrying out works, the designs for which have been prepared by the sanitary adviser to the Southern Command. These latter comprise works at the East and West Valley, Larkhill, and new works at Bulford for the existing camp.

In these works three different types of tanks have been installed, the largest being at the West Valley, where four tanks in parallel have been constructed, two being Dortmund and two being semi-Dortmund tanks, the effluent from which is carried across the valley in a 10-in. C.I. Syphon on to suitable land more remote from the camps. The East Valley works comprise three rectangular tanks in parallel, while Bulford extension consists of a roughing tank and four sedimentation tanks of rather novel construction. None of these works, however, have been in action long enough to allow any sufficiently correct data to be obtained which would permit conclusions to be drawn. It had been found in the existing works, both at Bulford and Tidworth, where large numbers of horses are kept, that scum on the tanks increased so rapidly that it reached the underneath of the concrete covers, and was gradually pressed down into the tank until scum and sludge met. The roughing tank at Bulford has been designed to obviate this difficulty, but it is too early yet to state results.

No filters have been provided for any of the foregoing works, disposal of tank effluent by irrigation having been found quite satisfactory; and where effluents have been discharged on to previously cultivated land concrete carriers have usually been provided, while on Down land dugout carriers have proved effective. Where possible, carriers have been arranged to allow for separate daily discharges, so that each portion of land can be given six days' rest if found necessary. One acre per 1,000 population, or thereabouts, has been provided where possible, but most Down land is so suitable for purposes of irrigation that much smaller areas have given excellent results. On the East Valley Outfall, Larkhill, where temporary works have been in operation since the summer of 1915 until the permanent works were completed this spring, ten units, or a population approximately of 11,000, with a daily flow of 110,000 gallons or thereabouts, have been most successfully dealt with in an area under three acres.

Generally, the author does not advise that irrigation areas should be cultivated, especially on non-permanent camp sites, as he considers that

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if land under irrigation does its legitimate work of sewage purification satisfactorily, it is all that can be expected from it, and where cultivation is undertaken on these areas there is a liability to neglect either the irrigation or the crops, often to the detriment of both ; therefore, one should be satisfied with work well done in the essential requirements for which the land is being used, viz., sewage purification.

This does not apply to Down land, where with proper attention excellent grass crops can be obtained ; and, as proof of this, last year the author cut and supplied in the form of green forage to the Army Service Corps at Larkhill, over 160 tons of grass—the small area of under three acres above referred to being cut four times, with a total yield of 60 tons.

Unfortunately, on these irrigation areas, no final effluents are procurable for analysis, and no actual results of purification are available for comparison.

Many variations from the original conception of the requirements for the drainage system developed as the camps became occupied. First urine was added ; then small concrete areas were provided at cookhouses for waste receptacles which had to be drained ; overflows from horse troughs in most cases had to be provided for, and generally the drainage system as originally laid down had to be extended. One of the most troublesome questions, however, arose when it was found that large quantities of grease accumulated on the surface of the settling tanks, and stoppages in drains took place. It soon became necessary to consider the provision of grease traps, and, seeing that at this time all drainage was practically complete, this meant considerable and somewhat costly alterations. It was decided to provide grease traps to all cookhouses.

MR. A. A. G. MALET (Sanitary Adviser, Southern Command) said some of the chief points to be considered in designing sewage disposal works, apart from the special circumstances of the site, was the water consumption : it was not safe to allow for less than ten, but it might go up to thirty-six, gallons per head per day ; the certainty of great variations in the strength, as certain " lines " in a camp would at times be empty for considerable periods, and at other times would be overcrowded for short periods.

A Cavalry camp might be transferred to Infantry or to the Tank Corps, or *vice versâ*, or a camp might be transferred to the Royal Air Force or converted into a hospital, with corresponding variations in strength and consumption of water, even if the hutments were not increased, reduced, or misappropriated.

The essential points in designing sewage disposal works for a hutted camp seemed to be : the interception of grease at its source of origin ; good detritus chambers, perferably in duplicate, with automatic sludging through bottom plug valves (not side valves) having a full bore lift ; the bars of screens or removable cages to have a clear spacing of not less than 2 in. ; the weirs of storm overflows to be protected by a dip board to reduce the risk of floating solids being carried over the weirs ; tanks in suitable units to allow of cutting out when the strength in camp was reduced, with efficient valves for drawing off the supernatant water and removing sludge. The total capacity to be six to twelve hours D.W.F.

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if the effluent was finally treated on land, and fifteen to twenty hours D.W.F. if the effluent was finally treated on filters. The form or type of sewage tanks to be adopted depended on the local circumstances in each case, but he preferred a rectangular tank where the sewage was on water carriage, and a modified Dortmund type when the system was not on water carriage. Sedimentation and not septic action should be aimed at ; if there was final land treatment, arrange for surface irrigation, not soakaways ; if filters, he felt sure that a duty of 45 gallons per cubic yard per day was too high for camp sewage, and if a high standard effluent was required, he doubted whether it was possible to secure one without double filtration ; humus tanks of two to four hours D.W.F. if necessary. If suitable land was procurable within a reasonable distance, it would give better results and avoid possible trouble to pump the tank effluent to land rather than to provide filters. No feed channel pipe or inlet at the disposal works should have a less depth at any state of flow than 2 or 3 ins., so as to ensure solids being carried forward but this did not apply to the discharge weirs of tanks or special gauging weirs. The design should allow for extensions or additions as the personnel of a camp was sometimes doubled or trebled.

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NOTICE OF MAGAZINE.

REVUE MILITAIRE SUISSE.

No. 11.—*November*, 1918.

THE STRATEGIC FRONTIERS OF BELGIUM.

The author of the original article states that Belgium has, strictly speaking, no " strategic frontier ; " she is entirely without natural defensive positions on every side, North, East and South. At one point only —between the two Limburgs—a river line forms part of her territorial boundary ; but even here owing to the mistrust which the Great Powers had of Belgium in 1839 to Holland was given the important bridgehead at Maestricht, although it is situated on Belgium's side of the river.

An inspection of historical and physiographical maps of the Low Countries, however, shows that on the North and on the East Belgium, at one time, was covered by exceedingly strong positions. Had the frontiers of Belgium not been altered, she would have had in 1914 three positions of the highest military value upon which to oppose the invading hordes of Germany. The paring of her frontiers in 1815 and in 1839 robbed Belgium of her natural frontier defences.

The possession of Luxemburg gave Belgium the positions on the line of the Moselle ; these positions, extending from Sierck to Treves, were exceedingly important as the right bank of the river, varying in depth from 1½ to 6¼ miles, belonged to Belgium up to 1815. The citadel of Luxemburg, which was occupied by the Prussians in 1867, in rear of the Moselle positions, had been recognized, from Vauban's time, to be the strongest fortress in Europe.

In 1914, the Grand Duchy of Luxemburg, neutralized and disarmed as it was, afforded an easy approach for forces intending to invade Belgium from the S.E. and France from the N.E. The absence of strong positions in E. Belgium compelled the Belgian General Staff to uncover completely the Belgian province of Luxemburg, and to take up a first line of defence on the left bank of the Meuse in the Namur region.

Up to 1815 there lay in continuation of the Luxemburg position the region of the Eiffel. Prior to the time when the central portion of the province of Luxemburg was nominally constituted a Grand Duchy—from 1815 to 1839—it comprised a mountainous region, on the right bank of the Our, contiguous to the present frontier of Prussia. This region extended northward along the high plateaus of the Eiffel, its edge formed the river partings of the Rhine and the Meuse basins. The whole of this country consisting of a dozen cantons, which had for centuries been Belgian, was obtained by Prussia in 1815, in spite of the declared intention of the Powers to make the Low Countries a powerful kingdom.

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The camp at Elsenborn and the considerable detrainment centre at Weismes, used by the Germans in 1914 as mobilization centres for the invasion of Belgium, were at one time Belgian territory.

Had the former frontiers of Belgium been preserved to her she would, in 1914, have possessed a suitable zone for the concentration of her army; under the actual circumstances, however, her eastern frontier was a mere *place d'arrêt*, with the heart of Belgium but two days' march from Germany.

Owing to the establishment, in the 17th century, of the Dutch enclaves at Maestricht and at Faquemont, the E. Limburg position was very much weakened. Although the situation was restored in Belgium's favour in 1815, yet in 1839 the establishment of Holland and of the North German Confederation on the right bank of the Meuse and the creation of the strong bridgehead of Maestricht, on the left of the river, again robbed Belgium of all that she had gained in 1815.

It was the existence of the Limburg "pocket" which caused the Belgian General Staff to concentrate the Belgian army on the line of the Gette, mid-way between Brussels and the German frontier; a Belgian concentration on the line of the Meuse, south of the Dutch frontier, would have been, in 1914, a hazardous measure owing to the possibility, always existent, of Germany violating Dutch neutrality for the purpose of invading N.E. Belgium *viâ* Dutch Limburg.

It is hinted, in the original article, that Belgium is laying "claims", on her eastern frontier, to the "strategic positions essentially and historically Belgian;" it is admitted that Belgium cannot be accused of "imperialism" on this account.

Had Belgium been allowed to retain her "natural frontiers," she would not, it is suggested, have submitted to the neutrality *imposed* upon her under the guarantee of the Powers.

Belgium, it is stated, has nothing to fear from Holland; the two countries must, owing to a community of interests, establish the closest of relations with and repose the utmost confidence in each other. The question of the Scheldt is touched upon in the original article, for the reason that its author considers it to be a matter of greater importance from the international standpoint than from that of Belgo-Dutch interests. The Lower Scheldt is the natural frontier of Flanders. At first sight it would seem that Belgium should exclusively control the left bank of the river. But Holland established herself on the Belgian side of the river in 1648, in order to carry out her particular policy of competition and in order to close the river and thus stifle Antwerp.

To-day, Belgium and Holland exercise a *condominium* on the Scheldt, which has never been clearly defined in law, and which since the beginning of the war, has been exceedingly precarious and almost non-existent. Both the Lower Scheldt and the Lower Meuse continue to be regarded as Dutch territorial waters. It would seem that owing to the force of circumstances Belgium has provisionally renounced the idea of making a military use of the Lower Scheldt.

The situation described above had a marked influence on the defence of Antwerp in 1914; the revictualling of the city and fortress was hampered, and the British fleet had to give up the idea of steaming up the

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Scheldt to co-operate in its defence. The retreat of the defenders was rendered more difficult by the existence of the strip of neutral territory along the south bank of the Scheldt, and the evacuation of the fortress had to begin sooner than would have been the case had what now is Dutch been Belgian territory. The vast national " keep " which, it was believed, had an exit to and an entry from the sea through the " free channel of the Scheldt " was found to be hemmed in by the neutral territory of Holland, and 30,000 men, belonging to the garrison of the great Belgian fortress, crossed into the neutral belt and, in consequence, had to suffer internment in Holland.

MONSTER ARTILLERY.

Public opinion, says the author of the original article, became exceedingly apprehensive when it was made known that the Germans had bombarded Compiegne, Dunkirk, Belfort and Paris at extraordinarily great ranges; the human imagination was quickened by the uproar caused by the explosion of giant shells.

It is pointed out that the recent progress in the development of firearms and of artillery has been largely rendered possible owing to new discoveries in chemistry and physics and to the improvements in industrial processes. Two absolutely opposite effects have been produced by the discoveries and improvements brought about in the fields of chemistry, ballistics and technology; whereas in the case of small arms a progressive diminution has been taking place in the calibre of the barrel of the rifle, on the other hand, in the case of artillery a constant increase in the calibre of heavy guns has been the order of the day.

The appearance of monster artillery on the battlefields of Western Europe was no surprise to students of ballistics. The presence of 12-in. guns on the Western and Russian Fronts was noticed early in the war; later there appeared announcements concerning the German 16.5-in. gun, the French 17.25-in. gun and the American 16.5-in. gun; and finally the construction in America and in France, of even 20.5-in. and 21.5-in. pieces was being discussed. In the case of the gun which caused the houses of the Isle de France to rock and to shake, it was not the magnitude of its calibre, but rather its extraordinarily great range which upset every one's calculations. The author of the original article states that it has yet to be learnt whether monster artillery will, on the modern battlefield, come up to all that is expected of it. It is suggested that the experiences of the war, now practically concluded, will, have provided the materials for the solution of the problems relating to monster artillery which, at the present time, are exciting the interest of so many persons.

Two questions are discussed in the original article, namely:—

(i.). What is the cause of the increase in the calibre of the gun?

(ii.). In the present state of modern science is there a limit to the continued increase in the calibre of guns?

It is pointed out that the question which the artillerist has to consider is the design of a projectile possessing great destructive effect at very long ranges. At short ranges the shell fired by field pieces and howitzers meet the requirements of the case effectively. But in the case of

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projectiles having a diameter of 6 ins. and over the destructive effects of such projectiles when exploded are insufficient ; neither the mass of the shell nor the explosive charge are large enough for the purpose required. It is difficult to reconcile in the design of projectiles the conflicting claims of an increase in mass, on the one hand, and of an increase of the bursting charge, on the other.

Given that a shell can be designed to contain a sufficiently powerful bursting charge and, at the same time, to possess strength sufficient to prevent it from breaking up prematurely on discharge, then, in order that it may accomplish the destruction of the target at which it is fired, such a shell must possess a certain minimum energy on arriving at its destination. The kinetic energy (E) or vis viva of a body moving through space is given by the well-known formula :—

$$E=\frac{M V^2}{2}=\frac{W V^2}{2g}.$$

that is to say, that the energy of a projectile is directly proportional to its weight and the square of its velocity ; consequently, the greater its weight and the higher its velocity the greater will be its energy.

In order to ensure that $\frac{W V^2}{2g}$ shall possess a large final value at long ranges, *i.e.*, when the projectile reaches its target at such ranges, it is essential that the shell shall have a large calibre and also considerable weight ; hence it is that in modern times both the diameter and the length of projectiles have been increasing.

Further, the penetrative power of a shell into compact masses of material depends upon its diameter. In order to destroy large masses of concrete, or steel cupolas of thick armour, very heavy shells travelling at high velocities and possessing a considerable bursting charge are necessary ; they alone retain sufficient energy on arrival at their target to accomplish the object in view.

The increase in the range of guns is due to the progress made in the manufacture of explosives which can now be produced with such perfection that any desired explosive force can be obtained in the propellant, with great precision of calculation, from the ingredients employed. The high quality of the slow-burning propellants and the certainty of their action are the factors which have made it possible to build the monster artillery which made its appearance on the Western Front.

With the very long shell in use in modern times a considerable rotatory spin, on its longitudinal axis, has to be given it in order that it may continue its flight steadily in a parabolic path. In order that the initial strain on the inner tube of the gun may be reduced as much as possible the pitch of the rifling has to be made small at the breech end and gradually increased until the muzzle of the piece is reached, where it is at a maximum.

Although in theory no limit need be set on the increase of the calibre of monster artillery, yet, on the other hand, experience dictates that there are practical difficulties which will finally determine the utmost limit of the calibre of such guns.

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The progress in metallurgy has been as great as that in the manufacture of propellants and explosives ; the advances and improvements in these two fields have mutually reacted on one another. The guns of the present day are constructed of nickel-steel ; some idea of the properties of this steel may be gained, when it is stated that, in order to obtain the initial velocity required in the case of very heavy projectiles, the breech of the gun has to be constructed so as to withstand pressures reaching 3,000 atmospheres, *i.e.*, about 19 tons to the square inch.

The use of slow-burning propellants renders it necessary that guns shall be extremely long ; it is essential that a sufficient time shall be given for the whole of the charge to be converted into gas before the projectile leaves the muzzle of the gun. The inner tubes of heavy guns (especially those of the naval type) vary from 45 to 60 ft. in length, *i.e.*, they are from 45 to 50 calibres long. The German " Big Berthas," which fired into Paris, had inner tubes varying from 72 to 84 ft. in length, and therefore their length was at least 100 calibres.

The increase in the length of the shell also imports an increase in the length of the inner tube of the gun ; this is necessary in order to give the shell a spin, on its longitudinal axis, at a suitably high angular velocity. Long projectiles require two driving bands, so that the increase in the pitch of the rifling must be gradual throughout the whole length of the inner tube, otherwise torsional stresses would be produced on such projectiles, stresses which would cause disturbances during the flight of the projectile and would result in inaccuracies in ranging.

Another matter which affects the accuracy of fire of monster artillery is that connected with the vibrations set up in the inner tube on the discharge of a gun. Such vibrations are in the nature of damped sinusoidal longitudinal waves, and, the material of the inner tube is consequently compressed and extended longitudinally along alternate portions thereof, in the same way that alternate stretches of condensations and rarefactions of the air are produced within a hollow cylinder when a sound wave is propagated through it.

These vibrations produce fissures in the metal ; in consequence, these vibrations constitute a serious detrimental factor in very long inner tubes of guns, and as they cannot be eliminated a limit is reached in practice beyond which it would be unsafe to lengthen the inner tube of a gun.

The wear of the inner tube is also a serious question in the cases of monster artillery. Such wear arises from the mechanical action caused by the inevitable friction between the driving bands of the shell and the lands in the rifling ; from the chemical action on the metal of the inner tube, producing erosion due to the high temperature (which often reaches 2,000° C. and more) of the gases formed from the combustion of the propellant ; from the calorific action of the hot gases which destroys the temper of the metal of which the gun is constructed.

The wear of guns depends on a number of factors ; among which are the quality of the steel used ; the care exercised during manufacture ; nature of the propellant used ; weight of the charge ; muzzle velocity of the projectile, etc. The most important of these factors is the weight of the charge; it has to be considerable in order to attain the muzzle

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velocities required. Whereas in ordinary field pieces muzzle velocities of 1,300 to 1,600 ft. per second are sufficient, in the cases of heavier guns muzzle velocities of 2,300 to 2,600 ft. per second are necessary. The Big Berthas that were used for the bombardment of Paris appear to have had a muzzle velocity exceeding 3,200 ft. per second. The charges used with ordinary heavy artillery are very large ; in the case of a 12-in. gun the charge weighs about 6¼ cwt.

Field guns have, it is stated, a life of from 500 to 600 rounds ; the lives of heavy guns are very much shorter, for instance, that of the 12.5 in. being 102 rounds and that of the 16-in. gun only 83 rounds.

Monster artillery occupies a secondary position in warfare ; its value is much less than that of smaller guns. The want of mobility on its part much detracts from its usefulness. In order to confer the maximum advantage to its side on the battlefield artillery should be capable of moving off the roads and away from railways.

Some idea of the transportation problem in connection with heavy artillery is obtained from the weights of guns now in use. The French naval type of 12.5-in. gun is 59 ft. long and weighs, without its carriage and platform, nearly 80 tons. The celebrated 42-cm. (16.5-in.) gun weighs, without its carriage approximately 88 tons, whilst the weight of the American 19.5-in. gun is 130 tons and that of its carriage and platform another 360 tons. These monster pieces have to be dismounted and taken to pieces in order to be moved from one position to another. It is said that 12 wagons are required for the transport of the 42-cm. gun, which, when ready for removal, consists of 172 different pieces ; no allowance is made for ammunition in these wagons. Moreover, several days are required to mount and adjust one of these monster pieces, and it is inconceivable that they will ever be available in a war of movement.

The fire from these guns cannot be regulated by any existing means ; even aircraft observation is out of the question. The successive shots must be fired haphazard, and therefore it can only be by chance that any particular target aimed at can ever be hit ; the dispersion with these guns is very great, as so many variable factors have to be reckoned with in connection with the flight of the projectile.

The ammunition supply for the heavy guns presents questions of considerable difficulty owing to the weights of the projectiles. The shell for the German 15-in. gun weighs 14¾ cwts. and that for the 16.5-in. gun 15 cwt. The projectile for the American 19.5-in. gun beats all records, it weighs 21¼ cwt. Ammunition of this description is as difficult to move as the gun itself ; hence, if the position of the gun is often changed, there is always a danger that the ammunition may run short, owing to its being stored at a depôt too far away from the emplacement occupied for the time being.

The cost of building giant guns is very great ; that of the French 12-in. gun is said to amount to £16,000, and the cost of firing a single shot therefrom is £190 approximately. The German heavy naval guns cost £16,600 a piece, and the firing of a single shot involves an expenditure of £340. Monster artillery is, therefore, a most expensive luxury, and the taste for it can only be indulged in on a very limited scale.

In spite of the difficulties connected with their use and the defects existing in them, the steel monsters, which played a part in the struggle on

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the Western Front, were none the less wonders of modern technical enterprise. The long period of trench warfare which followed on the decisive check to the advance of the German hordes after the first battle of the Marne afforded many opportunities for the utilization of heavy guns of position (brought into action in rear of a screen of field guns) for the destruction of the more formidable types of defensive works constructed by the belligerents on both sides.

The German 42-cm. gun may have been something to be proud of as a creation of modern science but it possessed little military value ; the use which was made of it to bombard towns far beyond the zone of contact between the fighting troops remains on record as one of the many indiscriminate and treacherous acts against innocent humanity of which the military and political leaders of Germany have been guilty, since the date, in 1914, when the frontiers of Belgium were crossed by the German armies.

MILITARY TRAINING AND MORALE OF THE SWISS SOLDIER.

The article on the above subject begun in the October number of the *Revue* (vide *R.E. Journal* for December, 1918), is continued in the number now under notice.

The author of the original article gives a description of the early experiences of a distinguished Swiss citizen, now a veteran in the Landsturm, in the Swiss Army as related to him by the latter ; it is not altogether complimentary. There was however, a redeeming feature in the situation described : a subaltern officer responsible for a part of the training of those called up in the now far-distant days to which the account relates possessed the capacity of interesting his men in their military duties and of instilling a proper spirit into them.

The object of military training, says the author of the original article, is to prepare young men to fulfil the greatest of their *civic duties*. It comprises two distinct aspects ; moral education and technical instruction. These two branches of the duty imposed upon a chief instructor are inseparable.

All military education, possessing real value, is based on *a sense of duty ;* a great variety of motives give rise to the sentiment involved herein, the chief among them being *love of country*. Patriotism, however, seems to-day to be at a discount, to some extent, in Switzerland as in some other parts of the world. A fashion has sprung up of replacing it by doctrines with bombastic titles having nothing Swiss about them ; internationalism, cosmopolitism, communism, even bolshevism, and many other words ending in " ism " expressing similar sentiments ; at one end of this scale stands " imperialism."

In France, too, some of these novel doctrines, introduced as a substitute for patriotism, were at one time making headway. The French nation have had to pay a heavy penalty in consequence. The war sprung upon them in 1914 has brutally dissipated these chimeras. In Switzerland, however, the situation is to-day far from satisfactory. A word of warning is raised by the author of the original article, who calls upon his countrymen to take the lessons taught by the recent lamentable experiences of Russia to heart ; he advises them to beware of living in a " fool's paradise." The day has not arrived when Switzerland can trust the defence of her frontiers to others, or place reliance on smooth promises

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or on " scraps of paper." Switzerland still needs an army, whose duty is a simple but a great one ; to preserve the Republic from invasion and the horrors of war. The mischievous anti-militarist propaganda now in progress in Switzerland is, it is said, seriously undermining the very existence of the State.

The duty of the officers, on whom naturally devolves the responsibiliy for the efficiency and *morale* of the Swiss Army, is, under the existing circumstances, vey clear. It is incumbent upon them to eradicate the virus of the anti-patriotic doctrines which is poisoning the minds of those under their command. They must not be afraid of refuting the sophisms which now have a vogue in Switzerland, of combatting the prejudices known to exist, and of providing a true explanation of things as they find them, without attempting to gloss over or to shirk matters which are disagreeable and unpleasant to handle ; it is possible for them to get their men to see things in their true perspective and to realise that the soldier's duty to the State and his real interests as a citizen are closely bound together.

The subject of " Discipline " is touched upon in the original article, and it is pointed out therein that the Greeks and ancient Romans, fanatical democrats as they were, insisted on maintaining a high standard of discipline, a standard which has passed into a proverb, and whereof they were justly proud. The need for discipline remains as strong to-day as at any epoch of the world's history.

There are many definitions of military discipline. In practice efforts are sometimes made to create and maintain good order in an army, by methods which can only be referred to as caricatures of discipline. These methods are made use of by officers who have little or no acquaintance with the laws of psychology. A true view of discipline is to be found in Capt. de Traz's work *L'homme dans le rang*, which the author of the original article advises every soldier to read.

The author of the original article has also something to say on " Drill " ; a subject which has given rise to much controversy and criticism in Switzerland owing to the misapplication of the rules relating thereto laid down in the Regulations for the Swiss Army. At one time, the real value of drill as an aid to discipline was so misconceived in Switzerland that even the men's dinners were practically served by a drill manœuvre, the cook's mates being formed up in line, called to attention, made to dress, to pick up mess tins by word of command and to march to the kitchens (using the ceremonial step).

The Swiss are exhorted to copy the example of the British and American Armies in their use of drill as a means to get the greatest output of energy from the soldier and to obtain the highest value from the military training given him. (*To be continued.*)

Notes and News.

Switzerland.—The editor publishes a letter dated Basle 5th October, 1918, received by him from Lieut.-Colonel Carl Frey of the Swiss General Staff, wherein complaint is made of the notice published, in the number of the *Revue* for September last, on Professor Allier's book *Les Allemands à Saint Dié ;* the notice in question should not, in Colonel Frey's opinion, have appeared in a *neutral technical and scientific publication* in view of

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the nature of the criticisms contained therein, which are alleged to indicate an unneutral attitude on the part of the writer of the review, who stated, *inter alia*, that Germany was responsible for the great world war.

The editor contests the views of Colonel Frey, whose notions on "neutrality," he says, are synonymous with "abdication." There is no reason, he continues, because, in certain quarters of Switzerland, a "capitulation of the heart and of intelligence" has distorted the views of a section of the people on certain matters that others should also surrender their spiritual independence.

Dealing with the queston of the responsibility for the war, the writer of the original Note points out the absurdity of the view that no reference in relation thereto can be made until such responsiblity has been judicially established. Attention is also drawn to the fact that both the *Berliner Tageblatt* and the *Frankfürter Zeitung* admit that the imperial military and naval authorities in Germany have been constantly and criminally guilty of telling lies on the above subject.

It is stated that Switzerland has had to mobilize her forces just at a time when America and the remainder of Europe were on the point of disbanding portions of their armies. Not having occasion to fight a foreign foe, Swiss troops have had to be called out in order to avoid Civil War. The cause of all the trouble in Switzerland arises from the fact that Zurich is under the domination of Germano-Bolshevik elements. The Swiss troops have, it is said, behaved in an exemplary manner in very trying circumstances. The situation in Switzerland is a peculiarly difficult one at the moment, but she has no need, it is pointed out, for a Hohenzollern with clay feet.

The influenza epidemic has claimed many victims in Switzerland, among those that have succumbed to the disease is Lieut.-Colonel Rouge Commanding the 5th Regiment of Infantry.

Great Britain.—An abridgment is published of the articles by R. K. Tomlin, Junr., which appeared in the number of the *Engineering News Record* for the 13th and 20th June last. The light railways constructed in the British sector of the Western Front are dealt with therein.

International News.—A short description is given of the allied "push" on the Somme, which began on the 8th August last; the events down to the 12th September are very briefly sketched. It is stated that during the period in question the French light tanks played a conspicuous part. There were three types of these tanks: the Saint Chamond, weighing 23 tons, armed with one long 75 mm. gun and 4 machine guns; the Schneider, weighing 13 tons, armed with one short 75 mm. gun and two machine guns; and the Renault weighing 6 tons, armed with one 37 mm gun and one machine gun. The last mentioned type can travel at a speed of from 7 to 8 miles per hour; numbers of tanks of this type have been engaged since the 27th May, and, during the period June to September last, have been daily making charges at the head of the French infantry, much as Murat's cavalry did at Eylan.

Notices on two books, *À l'École de la Guerre* by Major Jules Henches and *Traité de la Guerre*, anonymously published by Bossard of Paris, appear in the section of the *Revue* entitled *Bulletin Bibliographique*.

W. A. J. O'MEARA.

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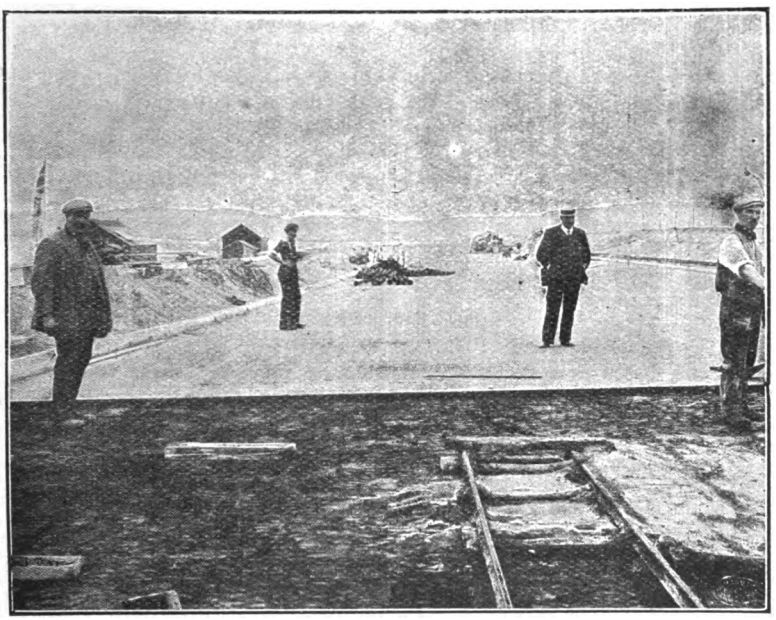

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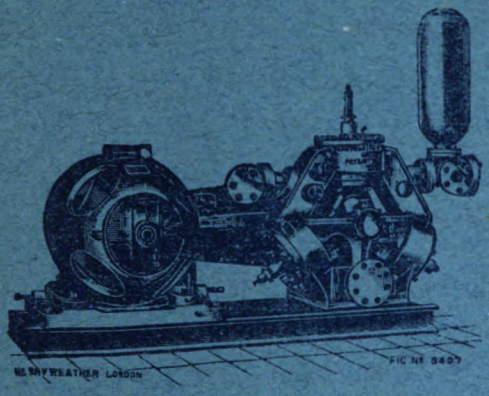

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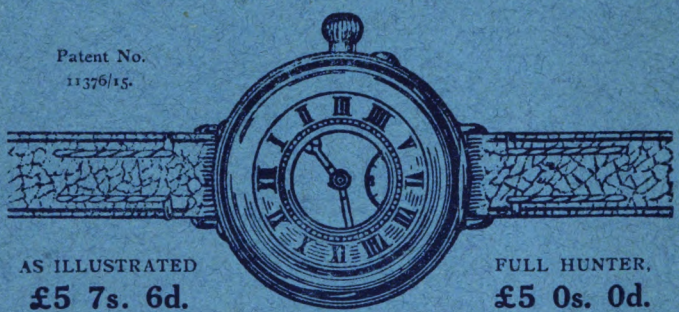

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Authors alone are responsible for the statements made and the opinions expressed in their papers.—(G. 5281).

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WORK BY R.E. UNITS IN THE WAR.

EXTRACTS from the Reports of Units to the Engineer-in-Chief, B.E.F.

17TH DIVISION.

Report dated October 25th, 1918.

River Selle.—On the 11th of October, 1918, eight infantry bridges were erected over the river, four to the north and four to the south of Neuvilly. The Engineers went forward with the first wave of an attack at dawn (it being found impossible to erect the bridges or reconnoitre river until then owing to the enemy holding a trench within 20 yards of the river), carrying small bridges, ranging from 12 ft. to 15 ft. which they had previously constructed. In two cases when the bridges proved too short, they were supported at one end by the sappers standing in the river under heavy M.G. and rifle fire and bombs thrown from the trench. After the infantry passed over, these bridges were made good. These bridges were continuously renewed until the night of the 19th October. On the night of the 19th an improvised tank bridge 18-ft. span, constructed of 20-ft. R.S.Js. (12×5) 4-in. decking, 12×12 transoms and sleepers which had been previously carried up and hidden near the site, was erected across the river north of Neuvilly. This bridge was completed by 2100 in an hour and 45 minutes, thus enabling the tanks to cross with the first wave of the infantry in the morning.

Further footbridges were erected on both sides of the village and were all complete by 2300. On the morning of the 20th, half an hour after zero, the two first-line transport bridges, one trestle and one of telegraph poles and other local material, were commenced on either side of the village. These were completed in time to enable the guns to follow up the infantry advance. The tank bridge was further improved. As soon as the advance had progressed sufficiently far, two bridges were commenced on the site of the main bridges in the village of Neuvilly, one (E.-in-C. D.P./755/1) to take all loads including tanks, and the other (E.-in-C. D.P./755/2) to take 12-ton axle loads. This latter was completed at 1845 hours on the 21st, although it had a direct hit while being erected. The tank bridge was completed at 1600 hours on the 22nd.

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3RD AUSTRALIAN TUNNELLING COMPANY.

Report dated 14th June, 1918.

A charge of ammonal had been prepared by Lieut. Wallman for Capt. N. T. Hartley of the West Yorks, to blow in a shaft leading from the German trenches to what was thought to be a dug-out. On enquiry for the charge at Tunnellers' Headquarters by Capt. Hartley, I arranged to first make a reconnaissance to find out if the explosion would in any way affect our listening system, and, if so, to prevent the demolition. I suggested we should go over in daylight, and Capt. Hartley agreeing, we went over accompanied by another West Yorks officer and a serjeant to remain in the German trench to give the alarm. I left Lieut. Sternberg in charge of the section in case of mishap. We arrived at the shaft mouth without accident, and Capt. Hartley leading, we descended the incline. As a shell had fallen near the shaft entry was difficult. The incline was about 1 in 3. At 14 ft. we met a block with a sniping hole in the centre and a traverse to the left. We cautiously advanced and completely traversed an apparently self-contained listening system of some extent, finally reaching an inclined shaft leading to a vertical shaft, which is badly crumped in. This and our shaft of entry were the only two entrances to the system, which was quite extensive. All the drives were 4 ft. × 3ft., close and very well timbered. We made a rough survey of all the drives, and noted anything likely to prove useful. I examined each face and found a conical hole in the centre of each, about 7 ins. deep and horizontal, evidently used to hold some listening instrument. We cut all wires and disconnected bells as we went along the galleries. Leads, evidently coming from a mine, buried in the floor were disconnected. We were over three hours in the system, and after collecting a few souvenirs hastily withdrew.

As unfortunately I had no compass I decided to return and take a few bearings, and tape off a few distances. Two hours later (8.30 p.m.) I returned to the shaft head, with a West Yorks lieutenant, who volunteered to come and help me tape. We entered again with the usual difficulty, and were able to get an accurate bearing, and tape off the incline and its extension. Fancying we heard an alarm we scrambled out. The magnetic bearing of the main incline shaft was 222. The demolition took place at 11 p.m. under the supervision of Capt. Hartley. It was completely successful. The charge was placed 16 ft. from mouth behind the block. I afterwards went over and examined the shaft to make sure the work of charge had been effective. The listening system showed no signs of recent occupation. Boot marks and refuse were examined carefully.

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We have established the fact that Bosche is not working in the system immediately in front of "C" Listening Posts, the system being at present unoccupied. Also that his main tunnel (of this system) is in very close proximity to "C" Listening Posts.

174TH TUNNELLING CO.

Special Report on Operations on 20th November.

We had been warned of the impending attack on Tunnel Trench by 16th Division, and were instructed to provide reconnaissance parties to go over with the assaulting troops and secure the tunnel against mines, booby traps, etc. The attack was timed for 6.20 a.m. on the 20th November. We had four parties of one officer and ten other ranks, each taking an active part, and a fifth party of similar strength in reserve. (On the 19th inst. a man of the 47th I.R. gave himself up on the right flank of proposed attack. On being questioned as to mines he said that he had attended a lecture given on the working arrangements of those in the Siegfried Tunnel and had also seen them. 16th Division invited us to come down and question the prisoner. He supplied us with some very valuable information, which was subsequently proved absolutely correct.) The parties were for convenience numbered, and detailed for work from right to left along the front of attack. A copy of Operation Orders is attached. No. 1 Party were assembled at No. 4 Mebus apart from the infantry, and as soon as the barrage lifted they advanced. For a reason unknown the infantry in this sector were late and our party reached Tunnel Trench just as the Huns were coming up out of the tunnel. The Huns immediately started to bomb our men and Lieut. Smith rushing forward scrambled to the top of Jove Mebus where he was killed almost at once. His serjeant and corporal were wounded by bombs and the remainder of the party lay in shell holes and sniped such of the enemy as showed themselves. The infantry were by this time coming over. Being now without either officer or N.C.O.'s confusion reigned among our men and eventually three unwounded men returned to our lines. No. 5 Party were immediately sent out to carry on, but on reaching Tunnel Trench found that the enemy counter-attack had driven our men in from the flank and that No. 2 Party had already established a block in the tunnel on the flank as then held. The infantry were invited to provide a bombing party to protect our men whilst they established a block further south, but as the protection was not forthcoming our party was withdrawn. No. 2 Party advanced with the infantry and entered the tunnel with the infantry bombers. All went well for a start and information of the Boche prisoner was found correct, so that

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the work of disconnecting mines went on quickly. The party was working southwards and owing to varying fortunes above ground the bombers had withdrawn but no information as to the failure on the right had filtered through. Presently the southern party consisting of an officer, a serjeant and a sapper encountered a Hun who immediately dodged up the nearest entrance and returned with bombers. An underground fight ensued in which our party gradually retired until they came to an entrance guarded by our men. Here they called for assistance and the officer started placing a charge whilst the N.C.O. and sapper held off the enemy. As soon as two bombers arrived our party made a determined rush and drove the enemy back to gain time for lighting up; then at the officer's signal all retired hurriedly, hard pressed by the enemy who must have been caught in the explosion. The explosion brought in the gallery and established a block breast high. When the smoke cleared no Boche could be seen or heard. The block was then increased to fill the entire gap by shovelling back débris and roughly setting the broken timber, it was in this state the tunnel was handed over. The No. 3 Party advance went perfectly and they entered the tunnel ahead of our infantry, encountering a pioneer officer and a group of men who showed a disposition to resist. The officer was discouraged by the combined efforts of our officer and a sapper, and the rest, 43 in all, surrendered. Twenty-seven mines characteristic of those throughout the tunnel, were disconnected and the leads cut every few feet. The mines were placed in open recesses on the west side of the tunnel and generally consisted of two heavy T.M. shells (200 lbs.) side by side with a primer box, laid across the top, into which detonators connected to the main cables were inserted. In a few cases, instead of two large shells, four smaller ones arranged for firing in precisely the same manner were used. As far as can be discovered the charges throughout the whole length of the tunnel between Fontaine and Bullecourt were arranged for firing from somewhere behind the line, and in all there seemed to be four separate circuits serving separate parts of the tunnel. From prisoners' statements the main cables were dug in beyond the parapet on the north side of the communication trenches, they were fitted with test boxes at various places and were dug in where they crossed a trench, their position being indicated by white tape pegged on the parados and parapet. They entered the tunnel behind the timber on the north side of their respective shafts. We confined our attentions to rendering these charges harmless, and did not have the opportunity of investigating the main controlling cables. No. 4 Party encountered some resistance before entering the trenches, and one of their mobile charges was unfortunately detonated and the sapper in charge blown to pieces and the officer slightly wounded. This party had thoughtfully provided themselves

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with a few Mills bombs and overcoming the resistance entered the tunnel by various entrances. At the one entered by the officer and corporal a large party of the enemy intimated that they wished to surrender. They were led by four officers, who, on seeing only a wounded officer and a corporal, evidently changed their minds for as he was about to pass them up the entrance the corporal was struck hard in the face by one of the officers. He countered and laid the officer out, bayonetted the next and threw the third down on top of a bomb, the rest surrendered without hesitation and the count became confused after 57. The only remaining officer, believed to be a major, was forced to show all the mines and also the defensive mining galleries. The mines were all disconnected and the Siemens Halske Electric (disc) listening apparatus taken from the galleries. In one case according to the captured Mining Plan one of the galleries was under Lump Lane near the Mebus, at a depth of 50 ft. The end showed signs of being chambered, but had evidently not been worked for some time. There was also a connection started to tunnel support.

The whole operation cost us the following casualties :—

	Killed.	Wounded.
Officers	1	1
N.C.O.'s	1	4
Men	2	5

and earned the Company the unstinted praise of both Brigades, Division and Corps.

Several scares have been investigated since, but nothing of importance has transpired. We have a party detailed in connection with a new attack on Jove Mebus. Their duties are to carry out the work originally allotted to the No. 1 Party.

46TH DIVISION.

Extract from a Letter from C.R.E., 46th Division, dated October 2nd, 1918.

* * * * *

" You will doubtless be pleased to know that Corpl. Openshaw of the 466th Field Co., R.E., was one of the first to reach the Canal on the extreme left of the attack. Three German pioneers were just about to blow up the brick arch bridge (Pont Riqueval) when Openshaw dashed at them, bayonetted two and took the third prisoner, and thereby saved the bridge which proved to be of the utmost value afterwards. The prisoner was then made to disclose the demolition charge which was soon extracted. This same corporal accounted for a machine gun nest on his way down the canal.

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The G.O.C. is very pleased about it and is going to give Openshaw the D.C.M. which he so richly deserves."

* * * * *

565th WILTS A.T. COMPANY, R.E.

Report on the Construction of a Bridge at Solesmes.

As a result of the reconnaissance of the site on the morning of 21. 10. 18, a 30-ft. span, A. type, girder bridge was decided on for the following reasons :—

(1). The old shore footings were in good condition.

(2). The wreckage of the previous bridge was lying in the bottom, and would have to be removed if a trestle or pier was required, which would take a considerable time.

(3). When the wreckage had been cleared away, a soft muddy bottom would have been found with a stream running about 2 miles per hour.

The completion was of the utmost urgency and an officer and 35 other ranks 181st Tunnelling Co., R.E. commenced work by clearing débris and preparing abutments at 1400 hours, 21. 10. 18. The first relief of 2 officers and 20 other ranks of the 565th Wilts A.T. Co., R.E. commenced work at 1800 hours. Timber for the footings was obtained at a German dump about 500 yards away. At 2000 hours the launching gear arrived on two lorries and off-loaded. Work was at once commenced on its erection. About 0400 hours on the 22nd, three F.W.D. lorries and trailers arrived with bridging material. This was off-loaded and a commencement made on the erection of the girders. A fourth F.W.D. and trailers apparently broke down on the road, and could not be found. By 1130 hours the launching gear was completed, the bridge seats finished, and the two girders, with the exception of a missing end piece, erected and cross-braced as far as possible. Work then ceased. At 1400 hours an F.W.D. and trailer arrived with a wrong section, and an urgent message was sent by despatch rider to the bridging dump for the correct section. This arrived at 1800 hours, was off-loaded and placed in position. While bolting this on at 1830 hours, gas shelling occurred, and helmets had to be worn for half an hour. Work recommenced at 1900 hours, but before the cross bracing could be fixed, another gas shelling took place, and work was stopped for half an hour. At 2400 hours the bridge was completed and ready for launching. Launching was completed by 0030 and the girders resting on the final off-shore sets. Hostile harrassing fire then commenced. Work was then begun on lowering the inshore ends of the girders on to its seat. During this operation the jack, which was being used for lifting, gave way, knocking the crib supporting the roller away and

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allowing the girder to drop suddenly on to a second set of packing, put in as a safeguard, just as a hostile concentration of shell fire commenced on the locality. By the promptitude and courage of No. 520106 Sapper E. Culling, of the 565th Wilts A.T. Co., R.E., an accident was narrowly averted to Lce.-Corpl. R. Butt, of the same unit. Work had to cease and the men took cover. During this shelling the hauling cable attached to the fore-end of the bridge was nearly severed, and was badly cut in two other places, another shell dropped within 2 ft. of the hauling winch, and still another within 5 ft. of the toolcart. By 0500 hours the enemy shells were falling in the east side of the village and work was recommenced and continued to a successful finish. The bridge was placed on its seats, the cross joists placed, strutted and bolted up, the decking fixed, approaches finished off, the launching gear dismantled and removed, and the bridge opened for traffic by Brig.-General Harvey exactly at 1200 hours, 23. 10. 18, the limiting time stated in the orders issued.

251ST TUNNELLING COMPANY, R.E.

Report of Work, 9th—24th April, 1918.

9th April.—The morning reliefs paraded as usual at 3.45 a.m., No. 1 Section proceeded to Portuguese Corps Area on road demolition work; Nos. 2, 3, and 4 to Givenchy. At 4.15 a.m. enemy commenced shelling back areas very heavily, using gas shells in considerable quantity around Essars. Company stood to arms at 4.45 a.m., and prepared to move off as ordered at half hour's notice. A cyclist orderly was sent to Bethune Signals to expedite transmission of orders. The Infantry (2 officers and 110 other ranks) attached from 164th Infantry Brigade, together with two officers and 53 other ranks of 165th Infantry Brigade, who had lost their way, were sent to report to G.O.C., 164th Infantry Brigade at 2.30 p.m. As the situation was obscure, picquets were posted on bank of La Bassee Canal as a precautionary measure. Capt. Auret was sent in direction of Cambrin to round up the morning reliefs which had been unable to reach Givenchy, and had been manning the Sailly-Labourse-Tuning Fork line. This was done and men returned to billets about 6 p.m. Capt. Walker, M.C., was sent to C.E., XI. Corps to explain situation and await orders. About 5.40 p.m. Capt. Evans, M.C., 5 officers and 179 other ranks proceeded to man Essars defences, being placed under G.O.C., 166th Infantry Brigade. As men came back to billets from outlying work they were given a small meal and sent to join Capt. Evans' detachment at Essars until, at 10 p.m., 9. 4. 18, its strength was 6 officers, 1 M.O., and 215 other ranks. Lieut. Landrey and 2 other ranks proceeded to Tuning Fork X Roads, to stand by the road demolition, keep-

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ing in touch with G.O.C., 165th Infantry Brigade. Capt. Auret was sent up to Givenchy to take charge of the Company detachment in the mines and dugout systems—total strength 4 officers and 40 other ranks, R.E., 1 officer and 25 other ranks attached infantry.

10th April.—For keeping in touch with Corps an officer was sent to C.E., with report every four hours, and cyclist orderly was maintained at 55th Divisional Headquarters; Company Headquarters was moved to Lannoy, and the attached 1st Portuguese Mining Co. to Gonnehem. One officer was withdrawn from Givenchy to assist in demolition work.

11th April.—An attempt was made to mine cross roads at Locon, owing to heavy shelling it was decided to put in bore holes from a convenient cellar. Lieut. Rees, with assistance of Lieut. Morgan and 9 other ranks, withdrawn from detachment working with 166th Infantry Brigade, was in charge of this work, and persisted until the cellar, in which they were working, was totally wrecked by a heavy shell. The " nature " of the ground was so shattered by the shell fire that they were unable to get in a bore hole. Consequently the work was abandoned, and party returned to billets. Headquarters was moved 300 yards at request of R.G.A. An officer was sent to C.E., XI. Corps twice in 24 hours instead of every four hours as previously

12th April.—1st Portuguese Mining Co. were employed in clearing old trenches along La Bassee Canal, until their occupation by British troops about 11 a.m. Lieut. Rees and 9 other ranks proceeded to Rue de Bois, mined the roadway and blew a charge of 250 lbs. blasting the resulting crater 38 ft. deep, effectually blocking the road. This was done within 300 yards of the enemy.

13th April.—The 1st Portuguese Mining Co., together with 1 R.E. officer from 185th Tunnelling Co. and 6 N.C.O. from 1st Army Mine School attached for supervision, was attached to 230th A.T. Co.

14th April.—The Gorre-Loisne road was successfully prepared for demolition by means of two bore holes. Charges were prepared, and 2 other ranks left in charge with full instructions as to demolition if necessary. The 166th Infantry Brigade detachment, under Capt. Evans, M.C., returned to billets having been five days in the Le Hamel-Locon area, during which time they had dug three positions, totalling 1,600 yards of trench, and a line of rifle pits, and improved shell holes over a front of 700 yards, one in neighbourhood of Essars, a second on the Le Hamel-Lawe River Switch, and a third from the latter to Mesplaux Farm. The work necessitated constant and severe digging, in addition to which they were required to man trench subjected to heavy shell fire. Casualties between 9th and 14th April: Killed, 2 other ranks; wounded, 1 officer and 8 other ranks;

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missing, 6 other ranks (from Portuguese Corps area). The 166th Brigade detachment was given 48 hours rest, and 3 officers (Capt. Walker, and Lieuts. Rees and Marsland) and 39 other ranks proceeded to Givenchy on April 17th, to relieve the detachment there, which had been in the mines since April 8th without any rest. The detachment in the Mines had taken active part in the fighting on April 9th, and had suffered three casualties (three other ranks wounded).

16*th April*.—Company came under administration of I. Corps.

17*th April*.—Company was divided into two detachments, viz. :—6 officers and 75 other ranks for work in two reliefs in Givenchy Mines, and the remainder, less Headquarters, for work on trenches under direction of C.E., I. Corps. This detachment worked until 19th April (three days) on a line E.8.d. to E.1.c., completing 1,638 yards of 1st task work.

18*th April*.—Enemy attacked Givenchy in force and overran the Bunny Hutch Subway and Caledonian dugout systems, taking the garrison prisoners after a severe fight lasting from 7 a.m. to 1 p.m. (A separate report, my C.61 d/d 22. 4. 18, on this affair, has been sent you.) Casualties to the detachment were :—Killed, 4 other ranks ; wounded, 1 officer (Capt. Walker, M.C.) and 2 other ranks ; wounded and missing, 5 other ranks ; missing, 2 officers (Lieuts. Rees and Marsland) and 20 other ranks. In addition to this, of the *personnel* Australian Electrical and Mechanical Mining and Boring Co. attached for operation for power plant at Pont Fixe, the casualties are :—Wounded, 1 other ranks, 251st Tunnelling Co., and 1 other ranks, Australians ; missing, 5 other ranks, Australians. Four casualties, 2 other ranks killed, and 2 other ranks wounded, occurred in the successful defence of Givenchy Keep, the O.C. of which reported that the Tunnellers (five in number) put up an excellent fight.

19*th April*.—Coventry Shaft bottom was visited, access from Wolffe Road exit, and found to be full to the roof with water.

20*th April*.— 1 N.C.O. and 4 other ranks volunteered as guides to accompany two Companies of 1st Northamptonshire Regiment in counter-attack to recover line at Givenchy occupied by enemy on 18th inst. Counter-attack succeeded. Casualties :—2 other ranks missing, and of another party working on the same front, 1 other rank wounded ; 1 officer and 10 other ranks started pumping out Givenchy Keep dugout system with hand pumps.

21*st April*.—Camouflet of 250 lbs. ammonal was blown cutting connection between mining system and Caledonian dugout system, and blocking off Piccadilly Exit from both. Casualties :—Killed, Lieut. Landrey ; wounded, 1 other ranks. The mining system Bunny Hutch Subway and Caledonian Subway systems were definitely abandoned and allowed to flood.

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Total casualties from 9th to 24th April :—

		Officers.	*Other ranks.*
251st Co.	Killed	1	6
	Wounded	2	17
	Wounded and Missing ...	—	5
	Missing	2	28
		5	56
Aus. E. & M. Co.	Wounded	—	1
	Missing	—	5
			6

(*To be continued*).

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THE FUTURE OF PERMANENT FORTIFICATION.

By LIEUT.-COLONEL H. E. G. CLAYTON, R.E.

SINCE the late Colonel J. F. Lewis, one of the ablest and best English writers on Fortification, ceased writing on this subject, his mantle does not seem to have fallen on any other R.E. officer. A revision of his *Permanent Fortification for English Engineers* and his edition of the second volume of the *Text Book of Fortification and Military Engineering* is much to be desired, and the present war must have made most R.E. officers speculate as to the future of Land Fortification. It is true that the matter is almost of only academic interest to the English military engineer, Coast Fortification being his normal occupation in peace time; it is obviously not desirable to discuss Coast Fortification, but the subject of Land Fortification will always be one of interest to the military engineer, and as will be shown later on in one case, Land and Coast Fortification have so much in common that the discussion of the one will throw considerable light on the other, and now that the art of permanent fortification merges so gradually into that of field fortification, in discussing the former we are, practically, discussing a good many points of the latter.

The most promising method of arriving at the necessary premises from which to argue is probably a process of elimination, for, if we ask the question "What it will not be?" we may by induction arrive at "What it will be." We will therefore, as a preliminary, reply categorically to the former question.

It will not include :—

(*a*). A continuous system or line of fortification along a frontier.
(*b*). Closed works on summits.
(*c*). Ditches deeper than about 15 ft.
(*d*). Masses of concrete or armour similar to those at Namur or Liège.
(*e*). Visible permanent emplacement for guns.
(*f*). As far as possible, surface indications of position that firing, support, reserve line, etc., will occupy.

Before proceeding to state what it must include, we must give here the reasons for the above.

No General who wished to gain a decisive victory would adopt (*a*) nor could any nation, however rich, afford to erect and maintain (*a*) or still more alter it from time to time to bring it into line with improvements in weapons.

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(*b*). Will not be adopted, as they merely become shell traps as at Liège and Namur, and therefore would not be worth the expense of construction.

(*c*). Will not be required, as concealed belts of wire entanglements are a much more efficient obstacle, though ditches with steep sides of a certain height may be necessary to protect the obstacle against tanks and similar engines.

(*d*). The objections to this form of structure are self-evident. This is necessary in order not to give away (*e*) the positions of guns before war is declared; possibly some might be constructed and afterwards covered with earth so as to be invisible during peace time.

(*f*). Similarly trenches might be dug, and concrete revetments run in, then the whole thing buried to be excavated in war time as required.

We must now consider what is necessary.

(*a*). As the position is not continuous, it must have protected flanks, *i.e.*, its flanks must rest on natural obstacles, such as rivers or the sea, or it must be circular, but we all know the viciousness of the latter, and it can be foreseen that few, if any, such positions would be required in modern warfare so that they can be omitted from any future discussion.

(*b*). The most important tactical points will be fortified in the manner indicated in (*e*) and (*f*) preceding, but it is conceivable that on the continent and on the east coast of England, very large wireless systems with anti-aircraft guns and searchlights may be kept permanently installed in order to prevent air raids immediately on or before the outbreak of war. These fixed anti-aircraft defences will be all the more necessary on account of the fact that rapid travelling anti-aircraft guns are very light and wanting in shell powers, and that from the very nature of things they must probably remain so. The arrangements adopted inland and those on a sea coast will be somewhat dissimilar. We will first discuss those to be adopted inland.

The anti-aircraft guns will require casemated barracks for their crews, and also in the case of land frontiers for protective troops, whose *rôle* will be to prevent the anti-aircraft guns being silenced by an " earth " force moving in concert with the enemy's air forces; in fact it looks as if in the future fortified positions will grow up round or in front of fixed anti-aircraft defences. As these fixed anti-aircraft defences cannot be without gaps between them, they will be supplemented by large numbers of mobile wireless sets, anti-aircraft guns and searchlights, whose *rôle* will be to occupy gaps, thicken the barrage, extend to the flanks or to take up reserve or supporting positions. This mobile equipment with their *personnel* will also be kept in bombproof and camouflaged casemates. Together with all these, though naturally not all grouped in one lump, will be the mobile and semi-mobile artillery of the " earth " defence

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with its casemates. Amongst all these casemates may grow up a large system of communicating tunnels or passages, since in addition to any permanent trenches for covering troops, concealed communication will be required between all these scattered units.

We are now able to forecast to some extent of what future fortified positions will consist, viz. :—

(1). Anti-tank ditches with obstacles (the construction of which is explained below).
(2). Positions for covering troops.
(3). Fixed anti-aircraft defences including wireless stations, searchlights, etc.
(4). Camouflaged casemates for aircraft, anti-aircraft, mobile and semi-mobile artillery, and Ordnance and A.S.C. Stores.
(5). Communications for traffic and everything included in the word " signals."

All these defences will primarily be located on the enemy's side of big towns, as it will inevitably be necessary to protect these centres of communication from air raids on the outbreak of war, the more particularly as regards towns situated near the frontier or sea coast.

(*c*). If anti-tank ditches are constructed their use will be limited to the most important tactical points, their trace will not follow the line of the intended fieldworks, they must have their own independent flanking arrangements which must be of a heavier nature than machine guns. They will serve as a useful site for and cover to such obstacles as high wire entanglement, they could conveniently be mined, as nothing would interfere more effectually with the movement of tanks than a mined ditch.

(*d*). Here and there, small concrete works must be used, emplacements for anti-aircraft and machine guns at the most important point, and observation posts for artillery, etc. In addition to these will be bombproof and completely concealed or camouflaged blindages for reserves, aviation hangars, artillery parks, stores, *et hoc genus omne*.

(*e*). Communications must now be considered.* As regards telephones. Only the trunk lines would be laid in peace, *i.e.*, up to the Section Commanders' positions, and these would be buried cable at least 6 ft. under ground. As regards railways and roads, it is a very difficult matter to lay down what should and what should not be constructed. A largely developed network of roads and railways in tracts of country in which they had not commercial object would at once reveal the main outlines of the defensive policy of the Government concerned. Only a very careful study of the local conditions

* (Here the writer is obliged to depart from the lettering which has denoted corresponding matter in the sub-paras. of succeeding paragraphs).

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would decide what should be done. For instance, in the accompanying plate the light railway or tramway might be constructed in peace time to serve the villages and farmsteads and bring their produce into the town, the small additions and diversions to make it useful for war time as indicated by the letters AA being constructed on the outbreak of hostilities, the necessary materials being kept in store in those bombproofs for the garrison which would not be otherwise utilized in peace time. In very easy country where the earthwork would be comparatively trivial the work might be left till war time, only the abutments of bridges and culverts being constructed, the erection of the girders being omitted until they are required. For instance, in the plate, the railway being constructed as far as "A," the remainder to "B" would be left to the outbreak of hostilities.

(*f*). If it is contemplated to move very heavy guns, such that they would require broad-gauge railways for their transport, it might in peace time be wise to lay out double lines of light railway, ripping these up in war time and laying single broad-gauge railways required on the earthworks of the double light railways in war time, the bridges being suitably constructed for this purpose and the heavy weights contemplated.

The principal difference in the defences constructed near the coast and those constructed inland would be the omission of the anti-tank ditches, their place being taken by broad belts of wire entanglement swept by machine guns so sited as to be invisible from the sea, or if visible at extreme ranges only. These items of the anti-air defence may have to be worked in with the general coast defences of the place, and as the discussion would now touch on coast defence, further reference to this portion of the subject will be omitted.

It will be seen from the above that any fixed system of anti-air defence will be very expensive both in men and money, and that only in the case of very important places can it be adopted, and that in almost all cases an efficient air service will be a better defence than anything else, a parallel between the air and the sea is here evident, which parallel however must not be pushed too far, in that there is no coast defence so efficient as an efficient navy, though in no case can coast defences be omitted altogether.

It is not proposed to here go into any details of construction, this short paper being written more in the hope of raising a discussion than with any other object.

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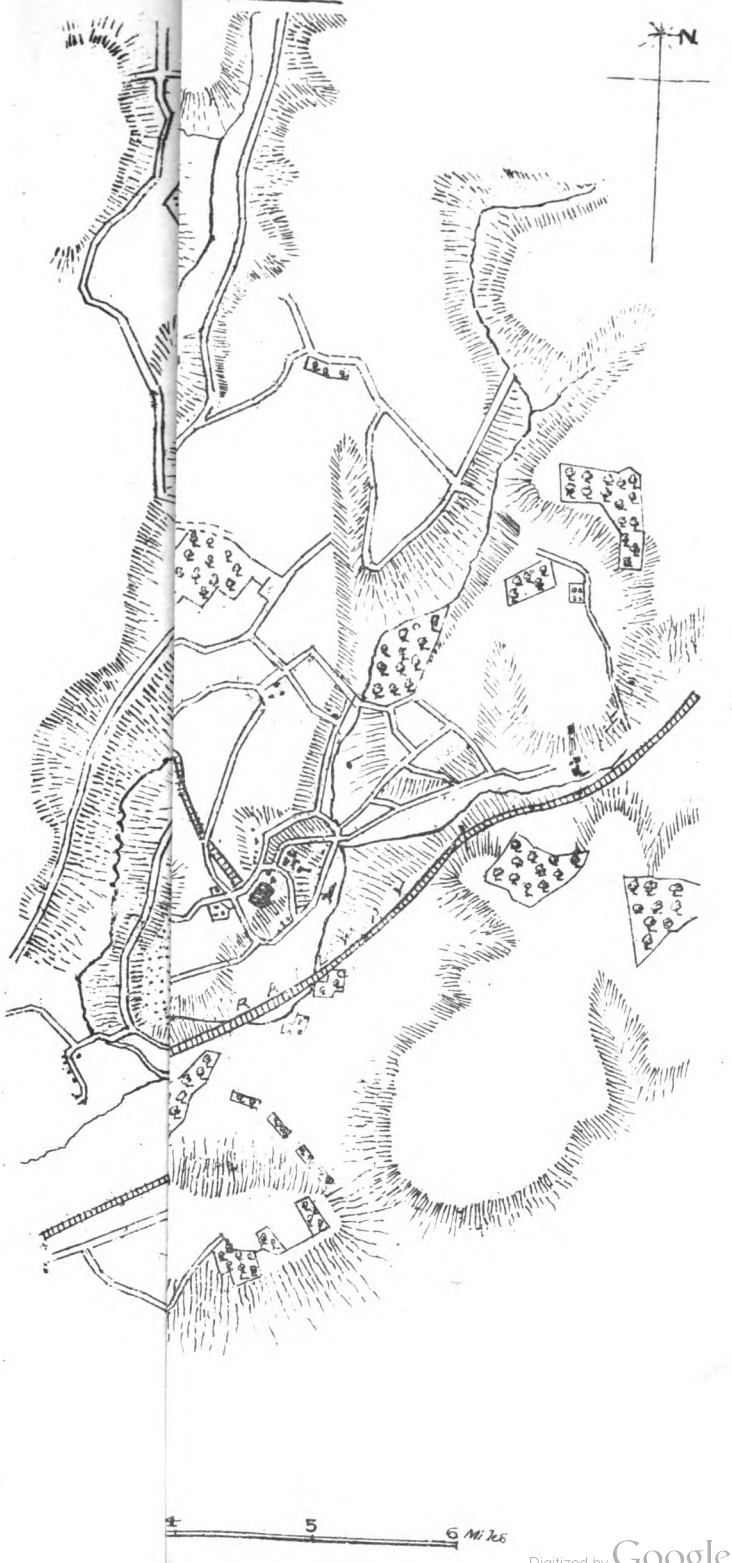

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CONCEALMENT IN FIELDWORKS.

By MAJOR F. D. NAPIER-CLAVERING, M.C., R.E. (S.R.).

IN the article on the above subject in the October *R.E.J.* the writer complains that the average R.E. officer does not make any attempt to adhere to the principle of concealment. He then proceeds to say that concealment is attained by studying the surroundings, by common sense, making careful plans before you start, and by discipline. Assimilate the surroundings by natural cover and if that is impossible use artificial camouflage. All this no doubt is very excellent as far as it goes, but even the arm-chair critic let alone the R.E. officer, who has been on active service for say a fortnight, knows as much. When the R.E. officer actually starts on a job of work, he finds that it is a mere council of perfection—hollow verbiage of no practical value. He is forced to the conclusion that nine times out of ten concealment is impossible. This conclusion under present conditions as a matter of hard fact is right.

One cannot hide from the enemy the fact that one is defending an area, and at present it must be considered impossible. It is possible however to retain surprise by concealing from him the *way in which it is defended.* This is done by (1), actually concealing important items in the defence ; (2), employing what is known colloquially as the second degree of concealment, that is, filling up the map with alternatives and dummies. The second degree is really a confession of weakness, requires a lot of labour, and is only possible in deliberate defence. In this paper the writer will confine himself to the consideration of the first method.

Now, if we want to advise young officers on concealment in fieldworks we had better start by considering what he can conceal, and what he cannot hope to conceal, and some of the more important difficulties he encounters on the ground. It is only by this means that we shall get a proper grasp of his difficulties and have any chance of assisting him.

Concealment from view is divided into two branches :—(*a*), ground observation ; (*b*), air observation.

(*a*). The former can be dismissed at once, because our officer can test his camouflage with his own eyes. It is quite definite whether he can conceal or not, and he can see for himself the result of his efforts.

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(*b*). He has also to conceal from the air, and more particularly the air photograph. Now the expert readers of air photograph in the British Army in France maintain that nothing can be hidden from them, and that whatever camouflage is attempted they are not deceived. 999 times out of 1,000 the R.E. officer on the job has not got an air photograph of his job. He knows practically nothing about reading them for the simple reason that he has never been taught. Probably he has never been up in an aeroplane. No wonder he thinks that concealment is impossible.

Camouflage Material.—When concealment from air photograph is attempted, experience shows that in the majority of cases natural camouflage is useless, and some artificial material is essential. More often than not this material is not available. To provide enough for all the defences constructed in modern war is an undertaking quite outside the region of practical politics. There is not enough even to conceal the guns in a modern defence sector, let alone any other works. For example, for a single headquarter dugout our sapper officer has to camouflage :—(1), at least four entrances ; (2), a dump of material ; (3), a huge dump of spoil, generally of the most dazzling colour and texture. He will be very lucky if he gets enough for this ; actually he hardly ever does.

The Time Factor.—All the time he is working on the job his superiors are continually urging him to get on with it, and show more progress. To conceal a work always adds very appreciably to the total time to complete. Very often therefore concealment is sacrificed to cover in the shortest possible time, and at any cost. Thus in order to have any prospect at all of effectually hiding a work, we see that the means of attaining concealment are primarily :—

1. Knowing what to conceal against (*i.e.*, having an air photograph and knowing how to read it).
2. Having enough *material* to do 1.
3. Having enough *time* to do 1.

Now the present ideas on the construction of fieldworks, held by the average officer, do not take the question of the air photograph into consideration at all. He designs his work, and then tries to conceal it, and usually finds that it is impossible owing to the excessive size and height. If concealment is essential it should be taken into account in the design, or it has no chance of being effected. The design must be modified :—

1. By study of the air photograph.
2. By camouflage material available.
3. Time available.

If this is done the sapper will have some chance of competing with the enemy Intelligence Department who, at present, are undoubtedly in a very strong position.

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Surprise has always been, and will always remain one of the most important principles of war. Next to the delivery of fire, concealment, by which alone surprise is effected, is therefore the most essential condition of fieldworks whether in attack or defence. The design must, therefore, be modified by it.

Fieldworks in defence can be divided roughly into fire positions and protection positions. The first includes all positions occupied by immobile defence weapons, automatic arms, rifles, T.Ms., and guns and their personnel. The second includes positions occupied by mobile defence (*i.e.* counter-attack troops), and by H.Qs.

Except where the infantry can retain surprise by movement, it has been found impossible up to the present to conceal their positions, and it is only waste of time to try. In the same way, T.Ms. and guns must rely very largely on movement or silent positions. On the other hand the M.G. and the H.Q. are necessarily incapable of movement. The M.G. because there is only a very limited area from which it can *best* deliver fire on a defined area. The H.Q. because of communications. Let us, therefore, consider how we may attempt to conceal in these two cases, which are definite examples of positions which *can* and must be concealed.

The Machine Gun Positions.—These form the framework of the defence in a battle zone, and constitute the one factor which modern war has proved to be essential in defence. It has almost always been the M.G. which has held up attack, not the rifle or the gun.

The first thing to guard against is a track to the position. This can be got over by having the position either on a road, or if no road exists, on a track. This latter *will* exist if there is no road. If the track is in the wrong place it must be diverted by wire fences over the right place, the diversion being made to extend well forward and well back.

Work should only be done when it is impossible to photograph from the air (*i.e.*, at night or on dull days) if camouflage material is lacking. Spoil must be moved down the track for at least 200 yards by barrow, hand-cart or waggon. In addition to concealment from the air, care must be taken to conceal from the advancing enemy infantry. Design of cover must be absolutely subordinated to concealment in the case of the M.G. positions. The idea of cover is to keep the machine gunner alive and effective after the enemy's guns have lifted for an attack. This is *not* achieved by making an obvious pill-box in open country. It will merely be neutralized by gas, smoke, and heavy guns before the attack commences. The more we depart from our essential tactical conditions of concealment by erecting obvious cover, wire, etc., the more fire we draw, and the more useless does the position become. The more we conceal the less fire we draw. It has then, only to endure searching and area fire. We must conceal

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therefore, not only to ensure surprise tactically, but also to obtain protection by avoiding fire.

The most difficult case is in absolutely open country. Here the cover must be not higher than ground level, but if it is splinter-proof and invisible it will be better than if it is shell-proof and obvious. It is a great mistake to let the wire indicate the presence of a concealed machine gun by placing the wire for exact enfilade. To sacrifice a few degrees of enfilade for the sake of concealment is very obviously worth while.

The H.Q. Dugout.—As in the case of the M.G. position, these are generally located by tracks in the first instance. The tracks to a H.Q. are converging. Tracks can be eliminated firstly, by building your H.Q. on a road or main track, and, secondly, by wiring off approaching tracks so not to give any clue as to the exact site of the work. It requires a lot of hard work and energy, as well as common sense and discipline to make success of the job, and it is a very difficult thing to do. It is always worth while and subject to the time factor possible. Figures 1 and 2 show a typical example of the anti-track fences needed before work is commenced. There are two alternatives of design, concrete or deep dugout.

Concrete implies heavy transport to the site, probably light railway siding, and consequent risk of observation, and is not possible under fire in the registered zone.

The Deep Dugout implies spoil, and is possible under the heaviest fire. Hiding the spoil may entail more work than the construction of the dugout itself. So far as concealment is concerned in the design, we have to decide for a particular case which of the two it is most easy to conceal.

1. The fact that we are taking several hundreds of tons of concrete to the site.

2. A large dump of spoil.

It depends on circumstances which is the best to use, but in both cases the problem is very much eased by arranging the site on a road or main track, on which to move the concrete or spoil without being detected.

To sum up. In order to conceal fieldworks we must first of all learn to read air photographs and study the effects which light and shade produce on the photographic plate.

Secondly, we must decide what it is possible to conceal, and what is impossible, and this decision must be modified by material and time available.

Lastly, having decided to conceal we must site and design so that it is possible.

Then, bearing these principles in mind we send out the young

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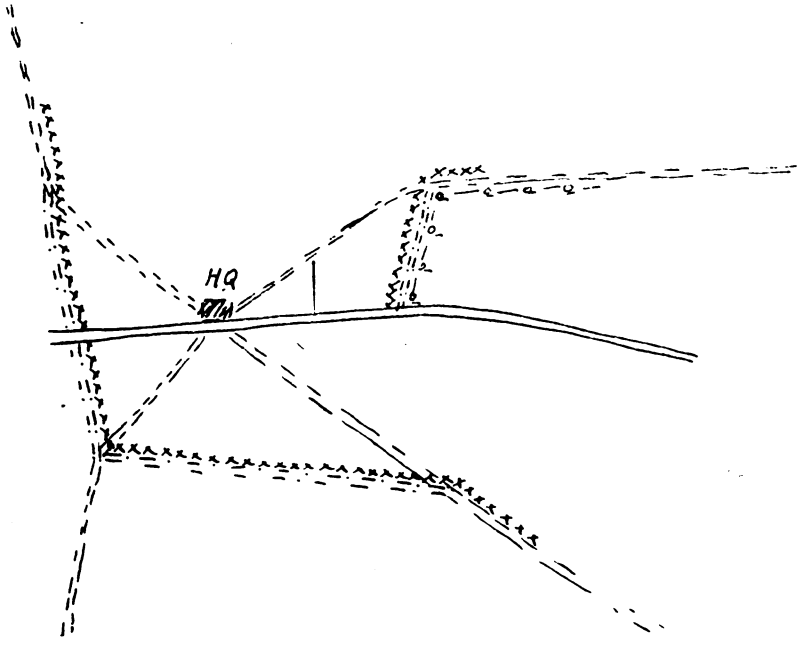

FIG. 1.—*Showing probable tracks to a H.Q. and wire to avoid them.*

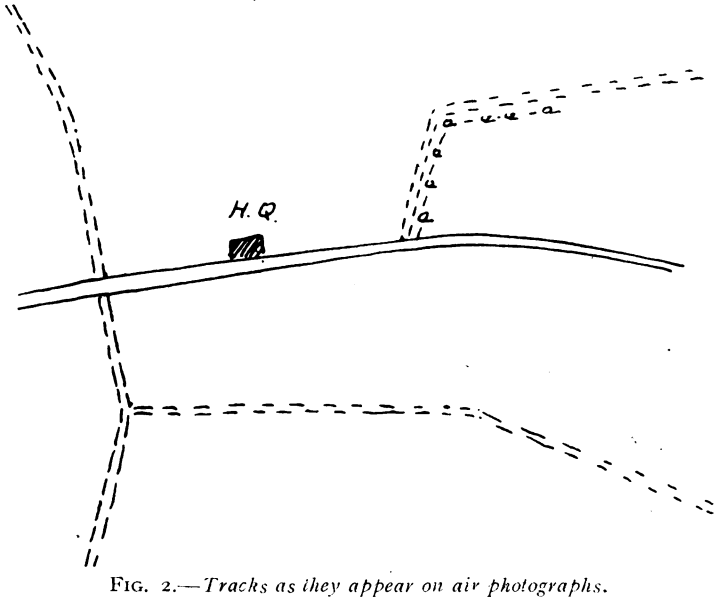

FIG. 2.—*Tracks as they appear on air photographs.*

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officer to do the job (with the air photograph in his hand). He will come back when it is finished not forced to the conclusion that nine times out of ten concealment is impossible, but eager to see the report as to whether the Intelligence can see anything on the air photograph of his job. He will understand that, *within very definite and narrow limits* concealment of particular, important works is possible, and essential. He will understand also that that oft-repeated phrase "Concealment of Fieldworks is *essential*" means—nothing at all.

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ARMY PIGEON SERVICE IN THE FUTURE.

By CAPT. E. E. JACKSON (Officer i/c Carrier Pigeon Service, Ireland).

THE useful work done by the Pigeon Service during the War is well-known, and it would seem probable that the military authorities must contemplate the formation of a *post bellum* nucleus pigeon service capable of rapid expansion to meet the requirements of our armies should they have to take the field again. I propose in this paper to discuss the requirements of such a service, the main considerations falling under the following heads, viz. :—

(1). The training of special classes of pigeons for the different uses for which they are required.
(2). Ensuring that a good supply of pigeons of the right kind are available at short notice.
(3). Ensuring a supply of experienced pigeon men to take charge of the pigeons at short notice.
(4). Training the army in the use of pigeons.
(5). Training of regular army men as experts in the management of pigeons.
(6). Arranging a supply of food baskets, message holders, message books, mobile lofts, general equipment.
(7). Carrying out experiments both in breeding of the best pigeons for the uses to which they are to be put, and with a view to improving the designs of the various articles of equipment of the pigeon service.

As regards (1) three distinct classes of pigeons are required :—
(*a*). Pigeons which will fly fast up to five miles in daylight, *and in dark and through thick fog.*
(*b*). Pigeons which will fly fast up to 25 miles.
(*c*). Pigeons which will fly fast up to 100 miles.

To get pigeons which will do this work in a satisfactory manner they must be bred from birds which have done this work for two generations back.

Class (*a*) pigeons should be not less than 16 ozs. in weight, with broad shoulders, rather a deep keel and tapering off to a fine point on the tail. The flight feathers should not be very wide, so that they do not over-lap one another. This class of pigeon should be trained to cover the distance both at night and in the day-time at the greatest

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speed possible. To get good results from this class of pigeon the utmost care will have to be taken both in their training and breeding, and special trouble will have to be taken to discover and select suitable pigeons for breeding this class.

Class (*b*).—The pigeons for this class ought to be not more than 17 ozs. in weight; bred much on the same lines as in class (*a*), but not so deep in the keel. These birds ought to be bred from parents which show a great aptitude for covering this distance at a great speed.

Class (*c*).—This class of pigeons should weigh from 15 to 18 ozs. with good shoulders, plenty of feathers, not very deep in the keel, short legs and wide back.

All the above classes (*a*), (*b*), (*c*), should be bred from parents which show great aptitude to cover the respective distances in the least possible time, but they must also be trained to do the distances themselves, and must on no account be trained beyond the distance allotted to them, otherwise bad results will occur.

It is of the utmost importance that the greatest care should be taken in the selection of the birds to breed from, as many pigeons will fly fast, but will not enter the loft on arriving home for various reasons. Many pigeons are troubled with nervousness, and on arriving at their loft rush about outside in place of, going into the loft; these are of no use from a military point of view and ought not to be used for breeding purposes, as the same trait passes on to the offspring for several generations.

(2). To ensure a good supply of pigeons of the classes required at short notice, lofts ought to be established at military centres for the breeding and training of class (*a*) birds. As this class will be much the most difficult to breed, the birds ought to be under the direct supervision of an officer who is an expert in the breeding and training of pigeons.

To procure pigeons suitable for stocking military lofts with (*a*) class birds, a fixed sum of money should be offered to any pigeon fancier who produces a pigeon fulfilling the requirements of this class, and willing to hand it over to the Government after it has been tested and found suitable by an officer appointed for the purpose. Authority should be given to the officer who carries out the tests to buy at a fixed price the parents of any birds which come up to the requirements. As a rule, any man who has kept and bred pigeons for a good number of years can almost always tell from the general characteristics of the parents what the offspring will be like. This class of pigeon will be most difficult to produce until they have been bred from two or three generations of birds which will do what is required; therefore every encouragement should be given to pigeon fanciers to breed enough in order to stock the military

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lofts, so that experiments can be carried out ; and a good quantity of this class of bird bred for use for the particular work they have to do.

(3). To ensure a supply of men capable of taking charge of a carrier pigeon loft, young men owning lofts of racing pigeons ought to be selected, and paid a retaining fee, so that they could be called up for service at very short notice should they be required. In selecting these men, care should be taken that they not only understand pigeons, but that they are physically fit ; a good amount of sickness occurred amongst the pigeon men during the present War, owing, no doubt, to a lot of the men being over military age. Men owning a good number of pigeons and willing to place them at the disposal of the Government should they be required, should be selected if possible, providing they are men who race their birds in a club where records of flights are kept, so that the officer i/c of Carrier Pigeon Service could see from the records, if the pigeons were being trained in a proper manner. The officer i/c Carrier Pigeon Service should have the right to inspect the lofts of men selected at any time, so that he may see if they are being kept in a proper manner.

(4). By keeping lofts at military centres and at the Signal Service and Regimental Signalling schools, birds would always be available for work with troops doing training schemes. It would be part of the duty of the officer in charge of the Carrier Pigeon Service to see that full advantage was taken of this, and that the army in general made proper use of pigeons during training and manœuvres. In this way, it could be ensured that the possibilities and limitations of the Carrier Pigeon became widely known throughout the peace army, and that the requisite peace practice was obtained in order to get the full value of the service in war time.

(5). Advantage could also be taken of these lofts to train a suitable number of serving soldiers as loft men. A month's actual work at the loft under the N.C.O. in charge should suffice for the instruction of any man who has a natural aptitude for the work and who is willing to learn. The O.C., C.P.S. would examine these men during and after their training, and successful men would then be registered by Records as pigeoneers and become available if required.

(6). An officer i/c Pigeon Service should be appointed and located at the War Office, his duties being as follows :—

(1). Supervising the military lofts and the training of military pigeon *personnel.*

(2). Acting as technical adviser on the use of the carrier pigeons in active operations.

(3). Responsibility for the scheme whereby civilian *personnel* are registered and paid retaining fees.

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(4). Selection and buying of suitable birds from which class (*a*) birds can eventually be bred at the military lofts.

(5). Responsibility for encouraging the breeding by civilians of birds suitable for classes (*b*) and (*c*), and arranging that sufficient suitable birds may be made available for the War Office at short notice.

(6). Experimenting and advising as regards the pigeon equipment, viz., baskets, books, moving lofts, etc., and seeing that the requisite reserves of the same are available and in good condition.

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Brigadier-General E. W. Cox, D.S.O., R.E.

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MEMOIR.

BRIGADIER-GENERAL E. W. COX, D.S.O., R.E.

Born 9th May, 1882, *2nd Lieut., R.E.*, 1900, *drowned in France 26th August*, 1918.

I AM very glad to have been given the opportunity of paying a last tribute to the memory of an officer whom I have considered for many years as one of the best, if not the best, that I have ever met.

My acquaintance with Edgar Cox dates from January, 1901, when I was Brigade Major, S.M.E., and he joined there from the "Shop" on passing out, first of his batch, into the Sappers at the early age of eighteen and a-half. Even then I was much struck by his ability, power of work and, above all, by his strength of character. This impression never weakened, and, during the four years of the war, during which I was brought into the most intimate relations with him, it developed into the highest admiration for his qualities of mind and heart. Few men had a higher devotion to duty, few so great a love of their work, few a more sterling common sense and few a stronger aversion for the mean and petty. His influence was always for the good and not many men have been so generally respected by their seniors and so loved and looked up to by their subordinates as he was. This was due to the fact that he knew his subject from A to Z and that he could always be relied on to give a sound and rapid judgment on any point connected with it. He never spared himself, and though he exacted the maximum of work from the officers under his orders, they always gave it him gladly as they knew that though he might ask much from them he exacted far more from himself.

Cox's great strength lay in his grasp of detail, combined with an unusual breadth of view. He was the author of *The German Army in the Field*, a book which has become the Bible of all Intelligence officers, not merely of the British Army, but of the Armies of all our Allies. That book contains every necessary detail connected with the composition and organization of the German field armies, and the appearance of its first edition in the early days of 1915 threw a flood of light on to many hitherto obscure problems It was the first and most essential step towards placing the British Intelligence Service on a scientific footing, and lifted that service at once into the high position

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which it has since maintained throughout the war. The amount of labour and research which it involved was only equalled by the rapidity and accuracy with which it was compiled. The preparation of this book and of its numerous editions, rendered necessary by the frequent changes in the organization of the German Army, together with the compilation of a similar work on the Austrian Army in the Field formed the main part of Cox's work during the year and a-half he was at G.H.Q. France and during his first year at the War Office. In the junior appointments he then held he became saturated with detail, but when in January, 1917, he took over the appointment G.S.O.1 of the section of the M.I. Directorate dealing with Germany and Austria, he at once devoted himself to a study of the political conditions in those countries and displayed a foresight and a width of vision of a remarkable kind. It was therefore with no misgivings that I was able to recommend him in January of last year for the very important appointment of Brigadier-General, Intelligence, on the staff of Sir Douglas Haig, as I was confident that there was no officer in the British Army so well qualified for the post. His success was instantaneous, and his appreciations of the situation, given at the Army Commanders Meetings in February and March last, marked him out as an officer of the highest ability, with an unrivalled knowledge of the German Army, of the mentality of the German Commanders and of the feelings and condition of the German people.

His merits met with the recognition they deserved and, even in these days of rapid promotion, few rose as rapidly as he. A Captain at the outbreak of war, he was given a brevet majority in June, 1916, a brevet Lieutenant-Colonelcy in January, 1917, and in January, 1918, at the age of 35, he became the youngest Brevet-Colonel in the Army, followed three weeks later by promotion to Brigadier-General. None who knew him could be surprised at or grudge him his success, and if he had lived he might well have reached the highest position in the Army. The Corps, of which he himself was so proud, may well be proud of him.

It was with a heavy heart that I walked beside him to the grave in which he was laid in the Military Cemetery at Etaples, but with me and with all those with whom he was brought in contact his memory will ever remain bright and unsullied as of one who left the world the better for his having lived in it. A good officer, a brilliant thinker, an untiring worker, a clean-living gentleman, and a staunch friend, it will be long before we see his like again.

G. M. W. MACDONOGH.

The following obituary notice from *South Africa* of the 12th October last, which we are permitted to print by the courtesy of the Editor of that Journal, gives the salient features of General Cox's career.

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The late Brigadier-General E. W. Cox, whose sad death by drowning we have already announced, was born on May 9, 1882, and was educated at Christ's Hospital, of which he subsequently was appointed a Governor. He received a commission in the Royal Engineers in December, 1900, and was promoted Captain 10 years later. From December, 1902, to October, 1903, he was employed on the Sierra Leone and Liberia Boundary Commission, and from 1904 to 1906 on the Anglo-Portuguese Boundary Commission. From 1906 to 1909 he was employed on survey duty in the East Africa Protectorate. From 1912 to the outbreak of war he served in the War Office as a General Staff Officer, third grade, and from August, 1914, to January, 1916, he served on Lord French's staff in France, where he gained the D.S.O. and Legion of Honour, and was four times mentioned in despatches. In January, 1916, he returned to the War Office as a G.S.O (2) with Sir George Macdonogh, Director of Military Intelligence. For services in the field he was promoted Brevet-Major in the Birthday Honours List, June, 1916, and for services at the War Office, Brevet Lieutenant-Colonel in the New Year Honours of January, 1917, and Brevet Colonel in the New Year Honours of January, 1918. He also received the Belgian Order of the Crown and the Russian Order of Saint Stanislas. In January, 1918, he went out to France as head of the Intelligence on Sir Douglas Haig's Staff with the rank of Brigadier-General, when Sir Herbert Lawrence was appointed Chief of Staff, and Lieutenant-General Travers-Clark Quartermaster-General. The late General married a daughter of Mr. and Mrs. P. Davis, of Morningside, Maritzburg, in March, 1912. The Rev. Richard Lee, formerly headmaster of Christ's Hospital, writes of Brigadier-General Cox: "May I be allowed to say something as to that young officer, whose early death (he was but 36 years old) has frustrated so many hopes and saddened so many hearts? For nearly nine years he was with me at Christ's Hospital. Special considerations caused me from the first to know more of him than of most, and I was in touch with him to the end. He rapidly passed up the school, taking prizes all round, and was just as keen at games and all outdoor life. At a very early age he came on to the Headmaster's classes, and in due course became senior 'Grecian' and an excellent captain of the school. Until 1891 its valuable exhibitions were tenable only at Oxford or Cambridge. Now, under the present scheme, they may be held also at any other place of advanced education approved by the Council of Almoners; and it was my privilege to recommend the first exercise of this new power in the granting of an exhibition to Edgar Cox, tenable at Woolwich, where he had gained admission (12th on the list of successful competitors) direct from the school. His career at the Royal Military Academy was the prelude to his brilliant career in the Army after obtaining his commission in the Royal Engineers. . . . On the school's long Roll of Honour

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no name will be more, or more deservedly, honoured than that of Edgar Cox. Strong, straight, clean, keen, selfless, humble-minded, loyal, true, he leaves a bright example of a character always prized as a moral asset in English life, never more valued or valuable than to-day, the character of an officer and a gentleman. 'A man greatly beloved.' *Nemo non parum amabat etiam qui non plus amare poterat.*"

In the *Geographical Journal* Colonel W. C. Hedley pays a tribute to the deceased officer. At the Royal Military Academy he was head of his batch, and won the Queen Victoria Gold Medal and the Pollock Memorial Medal. At the School of Military Engineering he was awarded the Haynes Memorial Medal. On his return to England in 1909 he was employed on military duties at Aldershot till May, 1912, when he joined the Geographical Section of the General Staff at the War Office, and he was so employed on the outbreak of the war in August, 1914. During these busy years he had found time to perfect his knowledge of French and German, and was an interpreter in both those languages. On the outbreak of war he was at once selected for work on the Intelligence Staff, and went to France in that capacity with the first expeditionary force. It had been his intention to go to the Staff College had not the war intervened, but it was soon evident that the lack of the Staff College training was no drawback in his case. He was soon noted as one of the most brilliant officers on the staff, and his rise was rapid. In the course of the present war the nation has had to mourn many young and brilliant men, but it may safely be said that it has suffered no more grievous loss than in the death of General Cox. He was a man of untiring energy, both physically and mentally, and being a very quick worker he got through an immense amount of work, and his work was of the highest quality. He was equally efficient at survey work of all kinds, or staff work, or at the ordinary work of an engineer officer. He was one of those men, and there are very few, of whom nothing but praise was ever heard. His name was a byword for efficiency. He had great confidence in himself, but was most unassuming. He was full of enthusiasm for the job in hand, whether it was a heavy piece of work or a football match. He never wasted time. He had a most cheerful and lovable disposition. It is a matter for infinite regret that he should have met with an accidental death when he had just reached, at a very early age, a position which gave full scope for his abilities. If his life had been spared he would surely have attained the highest positions. He leaves a widow and two children.

The *Geographical Journal* says: To Colonel Hedley's tribute to General Cox's ability as a soldier we should like to add some expression of the loss to geography which his tragic death has occasioned. General Cox was one of the British representatives at the International Map Conference held at Paris in December, 1913, and his colleagues will remember with admiration the extraordinary ability, energy,

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and tact with which he carried through the work especially allotted to him, the discussion of the conventional signs sheet. Unhappily, by reason of the war, this work is still unpublished.

General Cox had been a Fellow of the Society for sixteen years, and for several years a member of our Diploma Committee. He was largely responsible for the second and much enlarged edition of Colonel Close's well-known *Textbook of Topographical Surveying*, and in this, as on his boundary work, he displayed all the talents of a first-rate scientific geographer. Those who have been associated with him in this Society share with his colleagues on the general staff the sense of sorrow at the loss of one of those rare men who may truly be called irreplaceable.

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REVIEW.

PAGES D'HISTOIRE, 1914—1918.

(Published by the Librairie Militaire Berger-Levrault, 5—7, Rue des Beaux-Arts, Paris).

(*Continued from R.E. Journal for September*, 1918).

The 150th number of the above series is a Diary of the War covering the events of the half year, 1st July to 31st December, 1917; it is the 7th volume dealing with such matters.

The 151st number is entitled *Les Conquêtes Africaines des Belges;* it is from the pen of M. Pierre Daye and contains seven chapters which deal with German ambitions in Africa. In an appendix to the volume are contained copies of proclamations, extracts from diplomatic correspondence, etc.; a sketch map of German East Africa is also provided.

Chapter I. is headed *Le Problème des Colonies Africaines et les Ambitions Allemandes;* therein the story is told of German covetousness. Towards the end of March, 1914, von Jagow, at that time Secretary of State for Foreign Affairs, met M. Cambon, the French Ambassador at Berlin, at a private dinner and referring to the Belgian Congo, put the question to the latter: "Don't you think that King Leopold has placed a burden on Belgium's shoulders too heavy for her to bear?" The German Foreign Secretary appears to have dined well that evening, and to have been little reticent; he went the length of suggesting that France and Germany, possibly Great Britain also, might do a deal in relation to Belgium's African Colony. Needless to say M. Cambon was somewhat taken aback at the proposal made to him by the German Foreign Secretary.

The conversation recalled above was characteristic of German mentality. Germany, for many years past, had cherished vast and illegitimate ambitions in relation to Equatorial Africa. She had not hesitated to proclaim that she was inherently superior to all her rivals; further, it had been openly asserted in the official journal of the German Colonial party that "Germany had nothing to learn from Great Britain or any other colonizing nation, since she had a method of her own for solving social problems, a method which was peculiar to German mentality."

A people, so modest of their own achievements and so scrupulous as the disciples of Fichte are known to be, it is hardly necessary to say, were not satisfied with the slice of territory which their slimness and the complaisance of Great Britain had allowed them to acquire in Africa. The German pretensions regarding the Belgian Congo were no secret. Germany's three colonies on the African continent, the Cameroons,

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South West and East Africa, were cut off from one another by Belgian and Portuguese possessions, and such separation was a hindrance to her *Mittel-Afrika* scheme. • Hence, she coveted both the Belgian Congo and Angola.

The cession to Germany in 1911, by the Caillaux Government, of the strips of French Congo along the rivers Sanga and Lobe provided an indication that German eyes were turned towards the central plains of Africa. The German railway connecting the Eastern frontier of Belgian Congo to the Indian Ocean, the *Tanganykabahn*, was a commercial, and even a strategic, menace so far as Belgian Congo was concerned. But other evidence exists of Germany's designs against her little neighbour's possessions. The strenuous campaign conducted some ten years ago against the Belgian Administration of the Congo, under the ægis of the *Congo Reform Association*, was instigated, supported and financed by Germany. Edmund D. Morel and Sir Roger Casement were two of the most violent critics of King Leopold's *régime* in Africa. Both these individuals acquired further notoriety during the Great War ; the former was arrested in England on the 31st August, 1917, and sentenced to a term of imprisonment for attempting to convey documents secretly to Switzerland. Casement fomented the rebellion of 1916 in Ireland, and has paid the penalty which could alone atone for the heinousness of his latest crime.

In France, too, the names are familiar of defeatists and of suspect Frenchmen, who also lent their support to the pseudo-humanitarian campaign against King Leopold. Belgium also had within her own borders citizens who played the part of detractors of their own countrymen.

Much evidence is available concerning Germany's schemes for the conquest of the Belgian Congo. After the outbreak of the War, a paper, published in German East Africa, a copy whereof fell into the hands of Belgian troops operating in that territory contained the following statement ; " Moreover, we would draw attention to the fact that, after all, these Conventions (the Treaty of Berlin establishing the neutrality of the Belgian Congo) are but ' a scrap of paper ' (*nur ein Stück Papier sind*). We are just now engaged in a struggle for existence and cannot pay any regard to the conventions of international law ; we must alone consider the interests of the Fatherland. . . ." (*Die Kongo-Akte, vide Deutsch-Ostafrikanische Zeitung* of 22nd August, 1914.)

In September, 1914, Friederich Nauman coolly proposed, in *Der deutsche Krieg*, to France that an understanding might be arrived at concerning the " former Belgian territory of the Congo." Finally, shortly afterwards, under the pretext that the Boers were of Low German origin (*Niederdeutsch*), the ex-Kaiser's agents attempted to foment a rebellion on the southern frontiers of the Belgian Colony.

Belgium has long done her best to maintain the neutral character of the basin of the Congo, as provided for by Treaty. The Germans, on the other, did not hesitate to make use of the first opportunity which presented itself for the purpose of realizing their schemes. The German cruiser *Königsberg* made her appearance on the East African coast on

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the 1st August, 1914, and on the 9th *idem* treacherously fired on the British cruiser *Pegasus*, then lying off Zanzibar. At that time, and for several weeks afterwards, the Belgian Government continued its efforts to prevent its African Colony becoming embroiled in the War. In spite of the violation of the neutrality of Belgium by Germany, the Belgian Governor-General of the Congo, refused to fight the Germans on his borders. However, after the bombardment of Lukuga (Tanganyka) by the Germans on the 22nd *idem*, the Belgian defensive attitude came to an end and preparations were made for war. On the 29th *idem*, the Governor-General of the Belgian Congo was in express terms authorized by his Government to inform the German Governor-General in E. Africa that he had received instructions to make reprisals.

At the time that M. Daye was penning the story of the problem of the African Colonies, Germany had already lost her magnificent position in the great Southern Continent; Belgians had overflowed the frontiers of the Colonies of which the Teuton had been so proud in recent years: the situation therefore must afford von Jagow, and his ilk, much food for reflection.

Chapter II. is entitled *Bref rappel de l'histoire du Congo belge* and contains a short history of the territory which King Leopold had the foresight to secure for his country in the latter half of the 19th century.

In 1597, some three and a-half centuries ago, at a time when Belgium was struggling against the tyranny of Phillip II. of Spain and of the Duke of Alba, much in the same way that she has recently been resisting the oppression of William II. of Germany and General von Bissing, a group of Flemings, prefering exile to existence in a state of slavery, embarked on board-ship and sailed for the *terræ incognitæ* of the southern hemisphere. The vessel in which they journeyed made land somewhat to the southward of the estuary of the Congo, near St. Paul-de Loanda. Their lot was a hard one; the last of them died in the Azores. Again, about a century later, in 1652, Father Erasmus, of Furnes, set out from the Flanders coast with a party of 45 Capuchins for the same southern regions, in order to undertake mission work among the natives. History does not relate what became of this party, except that they reached the Congo.

It was, however, only during the past century that any systematic effort was made to reconnoitre and to occupy the great continent lying to the S. of Europe. Captain Tuckey ascended the Congo in 1816; an account of his journey up the Congo was published by a M. Douville in 1831. Livingstone marched across Africa from east to west in 1852; he discovered L. Tanganyka in 1869 and reached the banks of the Congo in 1871. An expedition was sent in 1874 in search of Stanley; he struck the Congo near its mouth and reached Boma about three years later, in 1877.

At the instigation of King Leopold II., a geographical Conference was held at Brussels in 1876; its outcome was the formation of the *Association Internationale Africaine*. A Commission, under the King's own presidency, and also an executive and a number of National Committees were formed by this Association.

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The International Commission met in 1877 and decided to send an expedition to Central Africa. The Belgian National Committee, in particular, was also extremely active and, during the period 1876 to 1884, sent six expeditions to Africa for the purpose of carrying out studies of various kinds; this was the beginning of the pacific conquest of the Equatorial region of the great continent.

On the advice of Stanley, Banana and Boma, situated on the Atlantic seaboard, were made the bases for the International Commission's Expedition. On the great explorer's return to Europe in 1878, King Leopold sought his aid for the purpose of entering into alliances with the native chiefs and the King, at the same time, founded the *Comité d'Études du Haut-Congo*. In 1879, an expedition led by Stanley founded Vivi and Leopoldville and ascended the great river.

The members of the Belgian National Committee entered at this time, into a large number of treaties, with native chiefs. The Association Internationale Africaine had only met once, and in 1882 gave place to the *Association Internationale du Congo;* the latter was recognized by the United States of America in 1884, and, in the same year, entered into a convention with France, whereby its suzerainty was duly recognized.

At this period, the representatives of King Leopold were in occupation of the whole region traversed by the Congo; however, the Portuguese Government laid claim to the estuary of the river. After a hot and lively discussion on the subject matters were smoothed over.

Bismarck recognized the Association Internationale du Congo, defending the New State, and, in 1884, called an International Conference at Berlin, in order to settle its future. About the same time, Dr. Karl Peters and his three companions, *in disguise*, concluded treaties with the native chiefs on the mainland opposite Zanzibar, whereby they secured German East Africa for their Fatherland.

The Conference held in Berlin in November, 1884, had three main objects in view: (*i.*) the establishment of the "open door" policy in the Congo basin, (*ii.*) the securing of the free navigation of this river and of the Niger, and (*iii.*) the framing of regulations to provide for the effective occupation of the Congo territories. The resolutions passed on this occasion are together known as the *Acte général de la Conférence de Berlin*. In February, 1885, the Powers represented (14 in all) recognized the Association Internationale du Congo as an "Independent Sovereign State;" it was further decided that the whole of Equatorial Africa should, under the name of *bassin conventionnel du Congo*, be declared a *neutral* region.

On the 1st July, 1885, the new state was proclaimed at Banana, and on the 1st August following, the Belgian Chamber, on the understanding that the union was strictly personal to the King, authorized Leopold II. to assume the title of Sovereign of the Congo State.

Thus King Leopold acquired vast territories without shedding a drop of blood or employing a single soldier to fight for him. However, his troubles were to come. In 1886, the Arab Chief Rachid began to set up extravagant claims in Central Africa. As a counter-stroke, King Leopold, in 1889, called an Anti-Slavery Conference together in Brussels—he had made his will in this year devising the Congo territory to Belgium.

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An expedition was now organized, and two years later hostilities broke out against Saïd-Ben-Abedi, Séfu and Rumaliza. The campaign lasted for three years, but the Belgians succeeded, in 1894, in crushing the revolt of the natives.

In the year last mentioned, the King's agents began to organize suitable administrative machinery for the government of these territories and to exploit its natural resources ; regular taxes were instituted, railway and telegraph lines constructed, law courts set up, etc.

In 1896, a Belgian Army was sent up towards the White Nile, under the command of Dhanis, to collaborate with Kitchener against the Mahdists. Revolts, however, broke out which hampered the advance of this Belgian force. In 1897, a Belgian force under Chaltin defeated the Dervishes, who retired in a northerly direction.

The frontiers of the Congo State were delimited about this time ; the negotiations relating thereto between the British, Belgian and German representatives on the Boundary Commission were extremely protracted, great difficulty being experienced in arriving at an agreement.

Revolts amongst the natives continued to take place down to 1908 ; in the last of them, Batetelas men, who had been enrolled in a constabulary, called the " Force Publique," for the policing of the Congo State took part. They have since then proved exceedingly loyal to Belgium.

The attacks on the Administration of the Congo State made by the *Congo Reform Association* resulted in the despatch, by Leopold II., of a *Commission d'enquêtes* to this territory in July, 1904. Certain reforms were recommended by this Commission, which, at the same time, made a handsome reference to the work of the King in relation to his African possessions.

The Belgian Chamber of Deputies nominated a " Commission " in 1906 to deal with the question of the annexation of the Congo State to Belgium. Two years later, excited debates took place on the subject in the Belgian Legislature ; finally, an Act was passed in August, 1908, annexing the Congo State to Belgium, and on the 15th November following it became a Belgian Colony.

In 1909, Prince Albert, as he then was, paid a visit to Belgium's African domain ; this domain has proved of very great value and of much strength to her during the period of trial, when an oppressive enemy was in occupation of a large part of King Albert's kingdom.

Chapter III. is entitled *L'Œuvre Militaires des Belges au Congo, de 1914 à 1918. Ceux qui la conçurent et qui l'exécutèrent ;* it contains a brief account of the wartime events in the Belgian Colony.

M. Daye is of opinion that perhaps, after all, it was a good thing that the Germans violated the neutrality of the *bassin conventionnel du Congo* in August, 1914 ; the result has been that the German colonies now lie in ruins, whilst the Belgian Colony has been revitalized. The Belgian Colonial Government was carrying out a reorganization at the time that it was taken by surprise by the German aggression ; it has, in consequence, had a prodigious task on hand in making arrangements for frontier defence and in organizing the forces which have been employed in the various colonial theatres of operations. Belgian troops have co-operated with the French in the Cameroons and against the Sultan

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of Mopoï; they have been operating in Rhodesia with British forces at Abercorn and Saisi; they have also taken part in the victorious campaign in German East Africa.

The Belgian Congolese Army, at peace strength, consisted, in 1914, of 18,000 black troops approximately; it was recruited by annual levies, voluntary enlistment and re-engagements. The annual contingents provided for under Article 16 of the Colonial Charter, normally varied between 3,375 and 3,750 men, but in 1916 the annual contingent was raised to 5,000 men. The terms of engagement are seven years with the Colours and five years in the reserve. In August 1914, there were 5,000 men in the reserve liable for service; therefore, on mobilization at the beginning of the War, the Congolese Army was made up to 23,000 men.

The great difficulty which the Colonial authorities of Belgian Congo have had to face has been in connection with the equipping, arming and feeding of the local troops and with the enrolling of the white population.

Although the Belgian Army in the Congo was a *purely colonial* one, it had to some extent to be supplied from Europe; two bases were formed for this purpose, one at Boma on the Atlantic seaboard, and the other at Mombasa on the Indian Ocean. In 1916, the Belgian forces in Africa numbered 20,000 men; two *colonnes d'invasions* (containing 12,000 men) each consisting of a brigade (two infantry regiments), a company of engineers, two batteries of howitzers and one battery of mortars, were formed under General Tombeur and were known as the *troupes de l'Est*. This General had also under his command the *Détachment des lacs* under Colonel Moulaert. The *troupes d'attaque* were supported by a *corps d'occupation*. General Tombeur's force co-operated with the British troops in the campaign for the conquest of German East Africa. Other Belgian detachments took part in the operations in the Cameroons and in Rhodesia; they were attached to the "Force Publique," and were controlled by the Headquarters at Boma.

Belgium owes a debt of gratitude to M. Renkin, her Colonial Minister, to whom is due much of the credit in connection with the preliminary steps taken to organize the African expeditions; he has been ably seconded in this task by M. Pierre Orts, Minister Plénipotentiary, and Major Auguste Couche. At one time there was a tendency to disparage the work of these three public servants, as often happens where men are more far-sighted than their fellows. The thanks of the Belgian nation are also due to General Tombeur, and all the responsible officers serving under him, for the skilful leading of the troops whereby Germany's military effort in Africa was brought to nought.

Short biographical sketches of M. Renkin and General Tombeur are contained in the volume under notice. The former is 56 years of age and began his career, in Brussels, as a barrister in 1884; he later took up journalism and politics, and was one of those who ardently advocated the annexation of the Congo State to Belgium. General Tombeur was born in 1867, and began his career in the 11th Regiment of the Line. He has graduated at the *École de guerre;* he first went to Africa in 1902. In 1914, when the war broke out, Tombeur held the rank of Major and

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was Vice-Governor General of Katanga; he was promoted General in 1916.

Chapter IV. is entitled *La Coopération belge au Kamerun et en Rhodésie* and deals with the part played by Belgian troops in the conquest of the Cameroons and in the support of the British forces defending Rhodesia against the Germans.

The Cameroons, acquired by Germany in 1884, owing to the initiative of Nachtigall and enlarged in 1911 by the incorporation of a part of the French Congo, covers approximately 202,000 square miles.

When hostilities began in 1914, the French troops on the Cameroons frontier endeavoured to establish themselves in the Lobe and Sanga valleys—the territories ceded to Germany in 1911—but not being strong enough for the purpose, the aid of Belgian troops was sought. In September 1914, the Belgian Government authorized the Governor-General of Belgian Congo to support the French troops operating against the Cameroons. This German Colony was almost entirely surrounded on land by territories belonging to the Allies, and British cruisers effectively blockaded its coast-line. The Germans had a large native army in this territory, with a nucleus of 2,000 white troops.

A description is given in the volume under notice of the part played by the Belgian troops, in support of the French forces, which attacked and captured N'zimu and Molundu (the former town fell on the 29th October, 1914 and the latter on the 22nd December, 1914). Later, these troops took part in the operations which resulted in the capture of Yaundé, on the 1st January, 1916, and in the final conquest of the German Colony, which was cleared of enemy troops by the 1st March, 1916—900 Germans crossed into Spanish territory and were interned. Shortly after the date last mentioned, namely on the 15th April, 1916, the Belgian troops returned to Boma and were given an enthusiastic reception—distance from Yaundé to the Congo=622 miles.

Whilst the campaign was being fought in the Cameroons, the enemy was also active in the S.E. region of the Belgian Colony. On the 5th September, 1914, a German force from German East Africa attacked the British at Abercorn. Belgian aid had been asked for and was immediately forthcoming. At the Sieges both of Abercorn and of Saisi, Belgian soldiers stood side by side with the British forces engaged in the defence of the two towns named, which are about 22 miles apart. The conquest of German South West Africa finally relieved the pressure in this neighbourhood.

Chapter V. is entitled *Le Conquête de l'Est-Africain allemand (du Congo à Tabora)* and deals with the events down to the 19th September, 1916, on which date the Germans evacuated Tabora (about 220 miles from L. Tanganyka) a former important slave trade centre (pop. 40,000) on the railway connecting the Lake with the coast at Dar-Es-Salam.

German East Africa and the Belgian Congo have a co-terminous frontier some 560 miles long; L. Kivu, the river Ruzizi and L. Tanganyka form the natural boundaries between these two territories.

The railway, known as the *Tanganykabahn*, running east or west, occupies an almost central position in the German Colony; it had not

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been completed when hostilities began. The main objective of the Anglo-Belgian troops was to obtain and retain control of this railway and the important centre of Tabora. The British forces numbered 42,000 men.

It is estimated that the German force in this territory numbered, in the autumn of 1914, some 36,000 men, of whom 3,000 were white troops; this force was well armed and had been reinforced by guns and sailors from the Königsberg, which had succeeded in eluding the British Navy and had taken shelter in the Estuary of the Rufiji River.

It appears to have been the intention of the Germans to invade the Belgian Congo and to march on Stanleyville. Between August 1914 and April 1916, a continuous series of minor engagements were taking place at different points. Both the Belgians and the Germans had armed vessels on L. Tanganyka, and these engaged one another at various dates: the German vessel *Kingani* was destroyed on the 26th December, 1915; the *Hedwig von Wisseman*, on the 19th February, 1916; finally, the *Wami* was sunk, by the British and Belgians, on the 28th July, 1916.

The Belgian preparations for the great offensive movement against the Germans E. of L. Tanganyka were completed in April, 1916, and the general offensive began on the 18th *idem*. The main force was divided, as stated earlier, into two columns, the North Brigade and the South Brigade.

The operations which led to the capture of Tabora are given in some detail, so far as the movements of the Belgian Brigades are concerned, in the volume under notice. During the short space of six months, the Germans were driven out of some 7,000 square miles of territory—an area six times as great as that of Belgium. In accomplishing its task the North Brigade marched some 930 miles, *i.e.*, on an average 155 miles per mensem, in a country inhabited by savage tribes; it had to fight the enemy continually as it moved forward.

Chapter VI. is entitled *La Conquête de l'Est-Africain allemand (de Tabora à l'Océan Indien)*, and completes the story of the defeat of the German East African Army.

After the capture of Tabora, the Belgians moved to the south of the railway and occupied the strip of country from the railway as far south as a line drawn from Karema on L. Tanganyka, to Sikonge, about 30 miles S. of Tabora. The German force which had been driven out of this region joined up with their compatriots on the Rufiji River, at that time, fighting against the British.

The Belgians, thinking that their task was at an end, had begun to demobilize and had started organizing civil government in the conquered territory; news then arrived that a force of 600 Germans with artillery, under the elusive Captain Wintgens, had arrive at a point near Neu-Langenburg, S.E. of L. Tanganyka, occupied by Rhodesians. At this time other German detachments had got away from the main force, being hustled in the south of the Colony by the British, and had invaded Portuguese territory, in the neighbourhood of L. Nyassa. General von Lettow-Vorbeck, who was in command of the Germans, could not hope to hold out for any length of time against the British; but an early peace would have enabled him to put forward the claim that there had

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never been an effective occupation of German East Africa. There can be little doubt that Wintgens adopted the course which he followed in order, if possible, to bring about a dispersion of the Allied forces, and thus to weaken the Allies' hold over the natives, some of whom still remained loyal to the Germans.

General Smuts' army, which had been severely tried by the climate, had just been sent back to South Africa and General Hoskins had recently succeeded to the command of a contingent much reduced in numbers. It was under such circumstances that, in agreement with the British Government, the Belgian Government ordered a remobilization of the force which had captured Tabora. General Tombeur had already returned to Europe and the command of the Belgians was, in consequence, entrusted to Lieut.-Colonel Huyghe ; he acted in close co-operation with General van Deventer, who had taken General Hoskins' place, the latter having proceeded to another important command.

A two-fold task lay before the Anglo-Belgian forces in East Africa : (*a*) the pursuit of Wintgens' column, and (*b*) the capture of the Germans in the Mozambique region and on the Rufiji.

Wintgens had, in April 1917, succeeded in shaking himself free from his British pursuers and had proceeded northwards by forced marches. A small Belgian force, consisting of three battalions under Major Bataille, occupied Sikonge and Ipole, on the 22nd May, in order to cover Tabora, which was immediately threatened by the German raiders. On the night of the 22nd-23rd May, a Belgian patrol captured Wintgens, who had been isolated, at a spot some 60 miles S. of Tabora. However, his men, now under Naumann, made good their escape and, continuing their march northwards, cut the railway 50 miles E. of Tabora. Two Belgian columns were in pursuit of Naumann, who proceeded in all haste towards L. Victoria. One of the Belgian columns overtook the German rearguard, about 145 miles N.E. of Tabora, and attacked it on the 7th June. Naumann, however, succeeded in getting away and reached Tumbiri (about 40 miles E. of Muanza) after a most daring march through a region in the occupation of the Allies. The Belgians continued their pursuit of the Germans, who retreated in an easterly direction. A violent engagement took place between the Belgians and the Germans on the 29th June, but Naumann got away again, and it was not till October, 1917 that he surrendered with his command to the British.

Fighting took place, during 1917, also in the region of the Rufiji River and of Mahenge. The Germans had laid waste the territory in the southern part of their East African Colony so completely that the inhabitants had had to withdraw in rear of the German lines owing to lack of sustenance. A small Belgian force was sent south from Uleia on the 11th August ; it was at first under the command of Major Bataille, later Lieut.-Colonel Huyghe personally assumed control of the operations in this region. The Germans were driven further and further south towards the frontiers of the Portuguese territory ; they halted on the 9th September and entrenched themselves, and attacks and counter-attacks took place over a period of several days. On the 16th *idem*, the Germans at last retreated, but on the 22nd *idem* they again made a stand

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a day's march N. of Mahenge, being severely defeated. Mahenge is the headquarters of a richly cultivated district.

The Germans now concentrated a force of 2,000 natives and 350 Europeans with artillery and machine-guns, under the command of Tafel, on strong positions in the neighbourhood of Mahenge. They were attacked by Colonel Huyghe on the 7th October, fighting continued till the 9th *idem ;* on the latter date, Mahenge was entered, many Europeans being captured and also much war material. Tafel, however, managed to escape in a southerly direction ; he was pursued by a Belgian force, which reached Liganga on the 16th *idem* and there effected a junction with the British troops under Colonel Fair.

Tafel endeavoured to join up with von Lettow-Vorbeck's command, but his force was hemmed in by the British and he surrendered on the 17th November, 1917, with the whole of the men under him. In the month of November alone, he lost 1,115 Europeans, 3,382 black troops, 6 guns and 73 machine-guns.

By the 1st December, 1917, not a single German remained in East Africa.

Chapter VII. is entitled *Les résultats. L'avenir ;* therein the events of the past are summed up and the prospects of the future discussed.

At the time that the volume under notice went to press, Germany was in occupation of about 1,125 square miles of Belgian territory in Europe, whilst Belgium held about 77,000 square miles of German territory in Africa. Under all the circumstances, the Belgians have reason to be satisfied with the achievements of their Colonial troops during the four years of the Great War. On the 28th July, 1914—four days only before Europe was in the throes of a violent convulsion—a decree had been signed in Brussels authorizing a decentralization of administration and an extension of local autonomy in the Belgian Congo. In spite of the War, the reorganization authorized by the decree has been completed, and the Congo is to-day divided into four Provinces : Kasaï, Equator, Katanga and the Eastern Province.

In addition to the financial and administrative reforms introduced, certain modifications have also been carried out in relation to fiscal, commercial and political matters.

During the War the Belgian railway system has been extended from the Lualaba to Albertville, on L. Tanganyka ; the custom revenue has increased from 8 million francs in 1914 to 13 million francs in 1916 ; the output of the mines has increased from a value of 7 million francs in 1914 to one of 14½ million francs in 1916 ; the export of copper has increased from 14,000 to 25,000 tons, etc. In every direction there are signs of increasing prosperity in the Belgian Colony, and to this fact the Colonial Budget amply testifies ; whereas the receipts were 32 million francs in 1915 and reached 43 million francs in 1917, the revenue of the Colony is estimated at 50 million francs for 1918.

The Belgian Congo has a great future before it ; it is rich in gold, diamonds, ivory, rubber, coal, copper, tin, iron, timber and agricultural produce. It is, however, still lacking in means of transport and requires an inflow of capital for the construction of railways and in order that its natural resources may be fully developed. A river flotilla is also neces-

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sary to make the most of its great waterway ; something is already being done to meet this requirement.

Belgians are warned to be on their guard as to the future, and to see to it that on the day of reckoning with their octopus-like enemy, suitable measures are taken firmly to close all approaches : otherwise, it is conceivable that *peaceful penetration* may succeed in restoring the situation lost to Germany in war.

It has been suggested that the German African Empire shall be divided between France, Great Britain and Belgium, and that, for the torments which they have suffered, the Belgian people should receive the *largest compensation* in Africa. It is the desire of many Belgians that by this means Antwerp may once more become a *grand entrepôt Africain.*

The Appendix to this volume contains *inter alia*, an extract from the " Acte Générale de Berlin " of the 26th February, 1885, wherein is set out the declaration relating to the neutrality of the territories comprised in the *bassin conventionnel du Congo ;* a copy of the letter, dated Berlin, 2nd April, 1914, wherein the Belgian Ambassador to the German Court communicated to the Belgian Foreign Minister the proposals of von Jagow with regard to the robbing of Belgium of her possessions in Africa ; copies of a number of the despatches from the Belgian Grey Book containing diplomatic correspondence—these despatches deal with the situation in Equatorial Africa after the outbreak of war ; a copy of General Aymerich's " Ordre du Jour " relating to the operations in the Cameroons ; copies of proclamations issued by General Tombeur in 1916 ; copy of General Tombeur's " Ordre du Jour " issued after the occupation of Tabora ; copy of King Albert's congratulations to his Colonial troops, who took part in the capture of Tabora, etc.

The 152nd number is entitled *La Magistrature Belge contre le Despotisme Allemand.* M. Fernand Passelecq is the author of the volume : he gives in nine chapters an account of the long struggle of the magistracy of Belgium with the German military authorities in connection with the attempt made by the latter to exploit the Flemish Home Rule movement and to restrict the exercise by the Courts of their jurisdiction in criminal matters, as provided for under the Belgian Constitution.

Chapter I. is entitled *Le plan de l'Allemagne pour diviser la Belgique et assujetir la Flandre à l'Empire ;* it deals with methods employed by Germany to bring Belgium under its vassalage by acting on the despot's maxim : *Divide et impera.* The German authorities endeavoured to exploit the duality of language of the Belgian people to accomplish their purpose.

The total population of Belgium is 8 millions ; the mother tongue of slightly more than half of these people is Flemish and of the remainder French. This linguistic division of the Belgians is very old ; it had its origin in the Latino-Frank civilization of Western Europe. For more than a thousand years Belgium has been divided geographically into a Flemish and a Walloon region. After long vicissitudes these two regions were brought, in 1830, into political union, a union whereby Belgium acquired its independence. The inhabitants of these two regions have, however, each continued to exercise the right to use its own original language in all official transactions. Administrative difficul-

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ties have been caused thereby in many ways, and not the least owing to the necessity of printing all official documents in the two tongues. Before the Great War, political capital was being made in some quarters of Belgium on the " question des langues," the principal manifestation in connection with which consisted in a complex movement called the " mouvement flamingant." This movement was in no way an irredentist agitation, but a matter which concerned internal politics alone.

The Machiavellian scheme of the Germans consisted in taking advantage of and in systematically exploiting the administrative difficulty arising from the language question, in order to convert it into a problem having importance in the field of international politics.

After the occupation of Belgium by the Germans, the embers of the old linguistic quarrel, which had almost died out, were fanned into flames. A few traitors were bribed, some wasters and knaves were got at by the invaders, and egged on to form a Flemish party, which became known as the " activiste " party ; the object thereof was to take active steps to bring about, with German assistance, considerable administrative and political changes in the country. Newspapers were started for the purpose of encouraging this movement, and hirelings were engaged to promote the propaganda in relation thereto. The movement resulted in the suspension of the constitutional guarantees in Belgium ; liberty of speech, the liberty of the Press, the right of public meeting were vouchsafed alone to the " *activistes*," the accomplices of Germany. The " mouvement flamand " was used by Germany as a cloak for making radical changes in the institutions of Belgium in order to fit the situation into her scheme for world hegemony.

Extracts are given by M. Passelecq from a speech of von Bethmann-Hollweg, delivered in the Reichstag on the 5th April, 1916, from the " political testament " of von Bissing and from a letter addressed by the latter to Deputy Streseman, on the 14th January, 1917, which throw a flood of light on the true character of the projects Germany had set her hand to in Belgium. Under the pretext of liberating " her German brothers from the yoke of the Belgian State," Germany was but intending to bring her dupes under her immediate domination.

Chapter II. is entitled *La réalisation du plan allemand. L'Université pseudo-flamande de Gand et la séparation administrative de la Flandre et de la Wallonie ;* therein are briefly described the three stages by which the German authorities brought their scheme into operation :—(1) On the 31st December, 1915, the University of Ghent was transformed into a pseudo-Flemish University ; (2) on the 21st March, 1917, the administrative separation of Flanders and the Walloon region was effected ; and (3) on the 19th January, 1918, a proclamation announced the grant of political autonomy to Flanders.

Germany was not sparing in her use of either money or of lies in connection with the deception which she attempted to practice on residents in foreign countries in relation to her schemes.

On the 4th February, 1917, the Belgian people read in the papers published by the " Kommandanturen " that a so-called " Diet of Flandres " (*Landdag van Vlaanderen*) had been summoned to meet at

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Brussels. It was gathered that some 200 to 250 individuals were members of this enigmatical assembly, the names of eleven of them had been mentioned in the German Press—these were persons of no weight in the country—whilst the names of the others remained practically unknown. How the members of the Diet had been elected, what electoral areas they represented, etc., were all matters concerning which the public remained ignorant.

Later, it was learnt (through the German Press) that this handful of insignificant personages had arrogated to themselves the title of "hommes de confiance du peuple flamand" and that they had constituted themselves the *Raad van Vlaanderen* (the Council of Flanders), and had signed a manifesto claiming representation at the Peace Conference on behalf of "oppressed Flanders"; seven members were, it was stated, proceeding to Berlin immediately to secure this object.

Von Bethmann-Hollweg received these seven pilgrims on the 3rd March, 1917, and promised, in the name of the Emperor, immediately to separate Belgium into two administrative provinces or "circonscriptions" (the line of demarcation being based on the linguistic divisions of the country). Effect was given to the preceding announcement in a decree issued by von Bissing on the 21st March, 1917—his last important governmental act.

But before this step was taken loud protests against the adoption of any such separation had already been raised in Flanders, which clearly demonstrated the *loyalisme flamand*. On the 10th March, 1917, exactly one week from the date of the reception of the delegates from the Council of Flanders at Berlin, Louis Franck, the Deputy for Antwerp, caused a letter, signed by 77 notables of the Flemish region, to be handed to the Imperial Chancellor; therein the artificial representations of the Council of Flanders were categorically disavowed in the name of the whole of the Flemish population, and the German Administration was challenged to seek a reply to the "administrative separation" question by a referendum to the whole country. This protest was followed by many others in which people of all social classes, without distinction as to residence or language, joined in large numbers.

Chapter III. is entitled *La tentative de démembrement politique de la Belgique*, and describes the steps taken by the German authorities to carry their scheme for the "administrative separation" through to completion in spite of the general and spontaneous remonstrances of the public.

Flemish and Walloon Belgium had, however, succeeded in getting its voice heard outside the limits of the invaded territories; the German Administration attempted, in consequence, to bind its victim more tightly and to thicken the prison walls, whilst it speeded up the execution of its scheme for the political dismemberment of King Albert's kingdom.

The German precipitation was probably due to the fact that her statesmen were "counting the chickens before they were hatched." The collapse of Russia had removed, for the time being, the menace on the eastern borders of the German Empire; the Wilhelmstrasse seems to have cherished the idea of repeating on the Western Front "the coup of Brest-Litovsk" by *ukrainising* Flanders. She hoped, by dividing the

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Belgian people, to create in the West a situation analogous to that which she had created in the East by the setting up of the semblance of popular governments in Poland and in Lithuania ; the German rulers probably anticipated that, once " administrative separation " was an accomplished fact in Belgium, they could openly enter into peace negotiations with the " activiste " group and obtain whatever moral advantage was to be derived from the successful issue of such a step. Whatever the reason, the Comedy was played, and on the 11th November, 1917, a meeting took place in the Alhambra Theatre, Brussels, of the "activiste" group ; not more than 1,200 persons were present (and of these one third were Dutch and one third Germans), every one of whom had been provided with invitation cards—under the circumstances there was nothing of the nature of a *popular movement* in the situation. At this meeting a resolution was passed abolishing the Belgian Government and its abolition was proclaimed by the frothy orators who had been demanding Flemish Home Rule in Belgium. On the conclusion of this meeting, the separatists were attacked in the Grand Place, whither they had proceeded, and were dispersed by angry patriots.

On the 11th December, 1917, two ordinances were published by the German Governor-General of Belgium in the *Gesetz und Verordnungsblatt ;* in one of them it was provided that, in cases where the German censorship had given its approval to any document, the jurisdiction of the Belgian Courts in relation thereto was ousted, and no action, civil or criminal, in relation thereto could lie. In the second of these ordinances the burgomasters in Belgium were deprived of their authority in relation to public meetings and their responsibilities in this matter were transferred to the German " Kreischief " (District Officer). Thus was impunity assured to the calumniators and the artisans of discord among the Belgian people ; at the same time, the reputation of patriots and of honest men was put at the mercy of all the Press agents of the " Kommandturen " throughout the invaded regions.

Under the shelter of the foregoing precautionary measures of the German authorities, the " activistes " were given free play to carry out their nefarious designs on the integrity of Belgium.

On the 20th January, 1918, announcements appeared in the German newspapers, and in the Teutonized Flemish Press, stating that the " Council of Flanders " had addressed a request to the Kaiser asking for the grant of autonomy to Flanders, and had resigned in a body so that the " Flemish people " might be given the opportunity to ratify this decision by " re-electing " the " hommes de confiance." The communiqués added that von Wallraf, the Secretary of State, had personally visited Brussels on the 15th January, 1918, in order to communicate, to the authors of the " separation scheme," the Kaiser's approval and that in consequence, the " Council of Flanders " had proclaimed the complete political autonomy of the Flemish region of Belgium ; the Flemish people were thereupon invited to make known their views on the whole subject at the " new elections."

Before the country had time to recover from the surprise, a handful of " activistes " met surreptitiously at the Alhambra Theatre, Brussels at 10 a.m. on the 20th January, 1918, and proceeded to hold a mock elec-

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tion. Owing to the vigilance of patriotic Belgians every detail in connection with this " electoral operation " was known ; exactly 607 persons were present in the theatre ; the meeting began at 10 a.m. and terminated at midday ; no steps were taken at the entrance of the theatre to verify the identity of the voters, there was no scrutiny of any sort ; the preliminary steps usually taken in connection with the candidature of individuals were ignored. The shouts of a few hundred riff-raff proved sufficient to " elect " 52 provincial councillors and permanent deputies for the province of Brabant and 22 deputies for the Belgian capital and district—normally, there are 200,000 electors in the Brussels district (population 1,000,000).

The manœuvre of the 20th January, 1918, was a mere piece of buffoonery; it was followed subsequently by similar grotesque " consultations electorales " in other towns. All these elections were carried through under the protection of German soldiers and police. It was thus that the " re-election " of the " Council of Flanders " was secured.

Chapter IV. is entitled *Le soulèvement du patriotisme belge ;* it deals with the movement of the Belgian patriots to counter the " activistes."

The German authorities had given the " activistes " of Antwerp, Louvain, Malines, Tirlemont and a number of other towns permission to hold meetings and have processions, during various dates in February, 1918 ; similar privileges were denied to other sections of the Belgian people.

At Antwerp an "activiste" procession, consisting of 600 to 700 persons, met with a most hostile reception. Some 30,000 inhabitants turned out to hoot and jeer at the " activistes " ; their banners and musical instruments were snatched from them and the procession was broken up, in spite of the German soldiers, who charged to disperse the loyalists. At the other centres named, the " activiste " processions were similarly attacked by the loyalists.

The Provincial and Communal Authorities of Belgium had hitherto remained at their posts and had continued to carry out their administrative duties, thus reducing the friction between the invaders and the Belgian people to a minimum. But the intrusion of the " activistes " into the political life of Belgium, and the strong support which they were receiving from the Imperial Authorities, was something that could not be tolerated by any Belgian institution owing its existence to the popular will. Communal Councils; Provincial Councils ; Deputies and Senators ; the Judicial Authorities ; the Universities ; Workmen's Associations; Chambers of Commerce ; etc., etc., entered most powerful protests against the traitors and usurpers composing the " Council of Flanders"; and all these bodies addressed collective letters to the Imperial Chancellor on the " activiste " situation. The German authorities took alarm and endeavoured to intimidate the Belgian officials who had had the courage to enter a remonstrance against the abuse of their powers by the invaders ; letters were addressed by the Presidents of the German Civil Administration in the Provinces of Limburg and Brabant to the burgomasters and aldermen in these provinces forbidding them to involve themselves in political questions.

Chapter V. is entitled *Le coup de Maître de la Magistrature belge,*

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and deals with the bold step taken by the judicial authorities of Belgium against the "activistes."

The Belgian magistrates and judges had, on the occupation of their country in 1914, come to the decision that they could best serve the interests of their countrymen by continuing in office rather by resigning in a body. Consequently, the Courts had continued to administer justice in accordance with Belgian law without interruption, and had arrived at a *modus vivendi* with the invaders. The Belgians had scrupulously carried out their part of the agreement, not so the Germans; in consequence, during 1916, 1917 and 1918 Belgian officials, one after the other, resigned their positions.

Justice continued to be dispensed in Belgium in the name of King Albert and the laws of the land remained in force, save in the cases of the exceptions contained in the ordinances of the German military and civil authorities. The Belgian penal code, however, continued in full force, so far as concerned crimes and misdemeanours committed by Belgians in Belgium.

The "activistes" seem to have overlooked the fact last mentioned, or were, perhaps, prepared to defy the Courts. On the 31st January, 1918, a group of Senators and Deputies took the bold step of denouncing to the "Cour d'Appel" of Brussels, the members of the "Council of Flanders" by name. In cases of denunciation of this nature the "Cour d'Appel" has a right to deal with the matters brought to its attention; its prerogative, known as the *droit d'injonction*, is based on the Criminal Code of 1810.

The "Cour d'Appel" met, on the 7th February, 1918, to deal with the matter to which its attention had been called; 46 out of the 48 members composing this Court were present (the absence of two members was due to sickness). A formal and precise charge against the offending citizens was duly laid before the Court, which ordered the Attorney-General to proceed in due form of law against the parties denounced and their accomplices.

To understand the gravity of the step taken by the "*Cour d'Appel*" it has to be borne in mind that the majority of the members of the Court belonged to the Flemish region.

In order that effect might be given to the "injonction" of the "Cour d'Appel," the Attorney-General appointed M. Bilaut examining magistrate to enquire into the charges; the latter issued summonses on the 7th February against all the signatories of the "activiste" handbills. The summonses against Tack, the President of the "Council of Flanders," and Borms, the Minister for National Defence, were served on the day following; delay took place in serving the other summonses as the persons named therein resided in the provinces.

Borms and Tack were arrested and conveyed to the Palais de Justice early on the morning of the 8th February and arrived there at 6.30 a.m.; the proceedings began the same day at 9 a.m.

Borms on his arrival at the Palais de Justice seized an opportunity which offered to instruct the German sentry on duty there to convey to the officer in command of the guard a warning that two ministers

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of the " Flemish State " had been arrested. The German authorities were dumbfounded by the steps taken by the Belgian judicial authorities; this exhibition of independence towards the all-powerful invaders appeared in the eyes of the German officials brought up in servile subjection to Prussian militarism to be an act of insolence. The Governor-General was some hours in coming to a decision as to his next move; finally, he decided to intervene on behalf of the " activistes " and to suspend the operation of Belgian criminal law.

Chapter VI. is entitled *Le gouverneur allemand arrache de force les meneurs activistes à la justice belge. Arrestation et déportation de hauts magistrats. Suspension de la Cour d'Appel de Bruxelles;* it deals with the high-handed action taken by the German authorities to secure the release of the " activiste " leaders and also with the reprisals that they carried out against the prominent members of the Cour d'Appel.

On the 8th February, between 10 and 11 a.m., one Schauer, a Justizrat, arrived at the Palais de Justice and proceeded direct to the Chambers of the Attorney-General; setting him aside, Schauer sent for the King's Attorney and the Examining Magistrate and demanded the immediate release of the " activistes " in custody, but he met with a firm refusal. A scene of great violence followed; Schauer, finally, by resorting to force, secured his ends; he seized the *dossier* relating to the case and compelled the surrender to him of the persons of Tack and Borms.

Having once started on this crooked path, the German authorities proceeded to extremes; on the evening of the 9th February, the Premier President of the " Cour d'Appel " and three Presidents of the Chamber were arrested. One of the Presidents of the Chamber was released, but the remaining three high officers of State were sent off to Germany to be imprisoned in the same gaol in which Burgomaster Max had been incarcerated since his deportation in September, 1914. Not yet satisfied with the mischief already done to the administration of justice, Schaible, the Chief of the German Administration in Flanders, issued an order on the 10th February, forbidding the members of the " Cour d'Appel " of Brussels to exercise their judicial functions. Thus, at one blow the independance of the judiciary of Belgium was completely destroyed.

Chapter VII. is entitled *Magnifique attitude de la cour de cassation et de tous les corps judiciares;* therein is described the measures taken by the Belgian judges further to outwit the Germans.

German officialdom has, as is well recognized, a poor instinct for psychology. Schaible's order was not many hours old before the Appellate Court was officially apprised, by the Attorney-General, of the arbitrary measures taken by the German authorities. This Court was requested to meet without delay to consider what steps should be taken in relation to the seizure of the *dossier* connected with the " injonction " of the " Cour d'Appel," and in the matter of the illegal release of Borms and Tack.

The Appellate Court accordingly met at 2 p.m. on the 11th February, 1918, when the Attorney-General read a report wherein he set out the whole of the facts connected with the denunciation of the members of the " Council of Flanders," the intervention of the German authorities,

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the arrest of high officials of the magistracy, etc. This Court thereupon passed a resolution declaring that the interference of the German Authorities with judicial proceedings in Belgium was not compatible with the absolute independence of the judiciary and that it was also illegal. It further pointed out that the arrest of some of the members of the " Cour d'Appel," and the suspension of the remaining members from the exercise of their duties was contrary to the fundamental rules of law and to the solemn promises made on the 22nd March, 1916, to the magistracy by the government of the invaders. The acts of the German authorities having deprived the judiciary of their liberty and independence, the Appellate Court, " without abdicating its functions," decided to hear no more appeals.

The Attorney-General was ordered to communicate the Court's resolution to the German Governor-General in Belgium.

On the following day, the 12th February, the Court of First Instance and the Commercial Court at Brussels unanimously decided to follow the example of the Appellate Court. The barristers also ceased to do professional work. Judicial bodies in all the important centres of Belgium passed resolutions similar to those passed by the Courts in Brussels, and by the 19th February, the work of all the Courts of Law in Belgium was at a complete standstill.

The judicial authorities had in every case taken care explicitly to declare that they had suspended the sittings of their Court " without abdicating their functions." Under the circumstances, the Germans could not introduce another system of justice into Belgium without a further breach of International Law.

Chapter VIII. is entitled *Le dépit du gouverneur général allemand. Un arrêt de réplique de la cour de cassation*, and deals with the attitude taken up by the German authorities in view of the difficulties in which they had placed themselves by their interference in the internal affairs of Belgium.

The German authorities in Belgium, taking their cue from Berlin decided to rely on the doctrine of force to see them through in their quarrel with the Belgian judiciary.

On the 10th February, 1918, there appeared an Official Bulletin of laws and ordinances for Flanders (*Gesetz und Verordnungsblatt für Flandern*) investing the " activiste " agents of Germany with official status, in order no doubt to protect them against a repetition of proceedings similar to those instituted before the " Cour d'Appel " of Brussels. Nevertheless, it became evident to the German authorities that their scheme for the " administrative separation " of the Flemish region was stillborn.

At a Cabinet meeting of Belgian Ministers held at Sainte Addresse, on the 15th February, 1918, a unanimous vote was passed approving of the measures adopted by the judicial authorities in connection with the " activiste " affair. Von Falkenhausen, the German Governor-General, on the other hand, could no longer contain his rage ; he made the mistake of acknowledging his discomfiture by replying, in bitter and pitiable terms, to the Appellate Court's resolution of the 19th February, 1918.

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Von Falkenhausen expressed the opinion that the "Cour d'Appel" had acted *politically* in taking cognizance of the denunciation of the "activiste," and that it had no right to take any action in the matter without first consulting the Chief of the German Administration in Flanders, who for the time being was in the position of Minister of Justice in Belgium. The Appellate Court had, said von Falkenhausen, failed in its duty to the Belgian people by having pushed its sentiment of solidarity with the "Cour d'Appel" to the length of suspending its sittings. The Appellate Court would have acted with greater wisdom and greater patriotism, continued the German Governor-General, had it continued to exercise its mission as the Supreme Court and confined its attention to the problems connected with the administration of justice under the conditions as they existed.

It is evident from the terms of von Falkenhausen's reply that he was confusing the situation created by the *occupation* of enemy country, one involving conditions that were temporary, with the situation arising from the *annexation* of an enemy's territories.

The Appellate Court met again on the 25th February, 1918, to consider von Falkenhausen's lecture to it; a further resolution was prepared, which the Attorney-General was ordered to transmit to the German Governor-General in Belgium. In this resolution the Court stated that the Governor-General, in stating that the Belgian tribunals were exercising their functions *under the authority of the invader*, had made a mistake as to the law in the subject and proceeded to show that, by the rules of International Law, when an invader retains the national judicial system in force in any occupied territory, he is bound to maintain it in the form in which it is constituted and composed under the constitution of the invaded territory; it is so provided under Article 43 of the Fourth Hague Convention of 1907. The opinions of German jurists were also quoted in support of the foregoing views; finally, the Court decided to adhere to the terms of the resolution passed on the 11th February, 1918.

The German Governor-General did not attempt to reply to the arguments of the Appellate Court, but an endeavour was made to persuade the judges to withdraw their decision; however, they had no confidence in the German Administration and felt that it was no longer possible to carry on any administration of justice which would be worthy of the name.

The German authorities were now left to their own devices, and on the 26th March, 1916, von Falkenhausen signed a notice substituting German tribunals for the Belgian Courts. The people in the occupied territory submitted to this last arbitrary act of oppression without entering any official protest. However, M. Carton de Wiart, the Belgian Minister of Justice, published a statement on the 16th April, 1918, wherein he dealt at length with von Falkenhausen's notice of the 28th March, 1918, and showed that the measures adopted by the German authorities were wholly contrary to the provisions of International Law.

Chapter IX. is entitled *Conclusion*; it sums up the results of the conflict between the Belgian judges and the German Administrators in the occupied territories.

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Germany's Armies, by reason of their great superiority in numbers, won many a victory on Belgian soil during the early days of the Great War; however, after the occupation of King Albert's kingdom, the invaders were held in check by the unconquerable spirit of Belgian citizens. Morally, the German Administrators met with defeat at the hands of officials in every department of State, and of every class of the people.

Germany has learnt during the past four years that the spirit of the people of Flanders and of Wallonia is as untameable to-day as it was in the time of the " grands communiers " ; the historian of these years of iron, fire and blood will, in all truth, be able to write: *the Belgian Nation has, once more, saved itself and its independence.*

The full texts of the several protests referred to in the volume and of the decrees creating German tribunals in Belgium are set out in a series of appendices.

W. A. J. O'MEARA.

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NOTICE OF MAGAZINE.

REVUE MILITAIRE SUISSE.

No. 12.—December, 1918.

The first article in the number of the *Revue* under notice is entitled *En l'année militaire dix-neuf cent dix-neuf;* it is a communication addressed to the annual subscribers by the Editor. It is pointed out that the year 1919 will be a critical period for the *Revue* and one of reconstitution. Costs of production are still rising; the increase in costs has already reached a level 500 per cent. above pre-war rates in some cases, whilst the lowest increase is 130 per cent. The *Société fédérale des officiers* and the *Section vaudoise des officiers* are thanked for their contributions of 1,500 and 400 francs respectively.

It is felt by the Editor that at the present juncture, *i.e.*, now that a return to peace conditions is so near at hand, the *Revue* must greatly extend its sphere of activity. The Swiss Army must, of necessity, enter upon an era of reform in consequence of the lessons taught by the War, and by its own experiences during its long mobilization, by reason of the new economic conditions within the Confederation and of the internal and external political situation. Reforms in training, reforms in organization, financial reforms, the home duties of the army, the duties of the Army in relation to world politics are subjects, should attention be confined to them alone, which, it is pointed out, will require much space for their discussion.

The subject of reforms in training has already been under discussion in the numbers of the *Revue* published in 1918; and the question of reforms in organization has also been touched upon. The Federal Chambers have recently instituted an enquiry on the subject of financial reforms; and the recent revolutionary occurrences, for which the so-called Soviet of Olten were responsible, imposed upon the authorities the necessity of employing the Swiss Army for the maintenance of internal order. The Revolutionary Committee has published its programme since the date of the *coup;* one of the planks therein consists of a demand for reform of the army and of a demand for its "popularization." Others also, including the *Revue*, put forward a demand for a reform of the army in almost identical terms, but the interpretation of the language used by the latter must be sought in a dictionary other than that used by the revolutionaries. What effect, it is asked, is the establishment of a "League of Nations" likely to have on the Swiss Army? The form that the League will take and the question as to what Nations will constitute its membership are matters of considerable interest and importance to Switzerland.

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Apart from the above matters, the *Revue* will, it is pointed out, have to devote considerable attention to technical matters, the range whereof seems to-day to possess no limits.

The instruction of the Swiss officer, it is suggested, will have to be organized on a broader basis than in the past ; there has been, in the past, too great a tendency on the part of military professors to adopt the German views in relation to the lessons of the 1870 campaign as alone affording guidance of value to the Swiss Army. The Great War with its multiplicity of battles and theatres of operations should have a considerable influence in altering the education scheme for Swiss officers ; officers must be taught, says the Editor of the *Revue*, that the success, or want of success, of particular operations is not necessarily the determining factor in assessing the value, *i.e.*, the soundness, or unsoundness, of the military measures conceived and put into execution in connection with such operations ; the methods of execution must also be examined.

A strong appeal is made for support of the *Revue* in the hard times through which the world is now passing.

Military Training and Morale of the Swiss Soldier.

The article on the above subject begun in the October number of the *Revue* (*vide R.E. Journal* for December, 1918) is continued and concluded in the number under notice.

The author of the original article points out that the example set by the " Chiefs " is one of the surest means of inculcating disciplinary ideas in the rank and file. The Nation has confided a twofold task to the Chiefs ; that of training the men for war and that of leading them in war. For this purpose, officers have been armed with authority and have had well defined powers assigned them under statutory sanction. But, in the same way that the wearing of a cowl does not necessarily make a man a monk, similarly the donning of uniform with the distinguishing badges of officer's rank does not necessarily make the wearer a military leader.

The *prestige* of a Chief depends on his personality, that is to say, the sum of his good qualities and of his defects. The most important quality in a Chief is love of his profession ; the Swiss Regulations lay stress on this point.

An extract is given in the original article from a work by Colonel Ch. Sarasin entitled " *Le rôle de l'officier subalterne*," wherein he states :— " I have always observed that the officers who are most devoted to their troops are those who exercise their command with the greatest zeal, energy and authority, and who, at the same time, cherish, in the highest degree, the ambition of having things in good order, the men well-disciplined and the training in the highest state of perfection, whilst the officers who are careless about their men are likewise indifferent and slack with the regard to the performance of their duties."

The existence of mutual regard and confidence between the Chiefs and their subordinates, it is pointed out, always promote good discipline and produce the happiest of results. The art of exercising command is summed up as consisting of few orders, those orders given in precise terms, clearly formulated and complete in every detail.

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The qualities of an ideal Chief are examined fairly fully in the original article. The opinion is expressed that these qualities can be acquired by a process of self-education, though much labour and patience must be expended for the purpose. However, the trouble taken in qualifying for leadership will bring its reward, since it is by this means that the maintenance of discipline is, as a rule, most easily secured. The task of a Chief is a complex, delicate and difficult one. The expenditure of much effort is required in accomplishing it ; thereby alone can victory be achieved.

In dealing with the means for enforcing discipline, the author of the original article points out that the best of the punishments, it has been claimed, can hardly be called good. But since armies are not composed of supermen, existing punishments, such as they are, must remain a necessary evil. In every army, unfortunately, there are found a certain number of evilly-disposed individuals, who possess no " better side " to their nature to which an appeal can be made. Even in the case of troops who are most highly disciplined, there will, on occasions, arise infractions of the military code meriting severe punishment. Nevertheless, it would be a very serious mistake on the part of a Chief, it is pointed out, to suppose that discipline can be secured by resort to a system of punishments alone ; such might have been the case in the days of mercenary armies, the members composing which feared neither the Creator nor the devil. To-day, a reliance on such methods would, in the case of a national army, be worse than a criminal expedient. The time has arrived for definitely abandoning systems of discipline which rely on " terror " for their enforcement.

Collective punishments are naturally condemned ; they are nearly always unjust and place the well-behaved and the ill-conducted soldier on the same footing, thus creating a mischievous sense of solidarity throughout the ranks in the matter of grievances. The effect of such punishments is to lower the confidence of men in the spirit of equity expected in their Chief.

Punishment should always be certain ; that is to say, should the offence be serious, the nature of the punishment awarded should be severe and determined in relation to the gravity of the offence ; it should be enforced with firmness. On the other hand, the infliction of punishment should be a rare occurrence ; this does not mean that wrong-doing should ever be overlooked. It may be taken for granted that, should the circumstances be such as to necessitate the frequent awards of severe punishment, the situation should be considered as having become abnormal and should consequently be carefully enquired into with the object of ascertaining what has gone wrong in the unit.

The Swiss Regulations lay down the nature of the punishments which officers are authorized to inflict on soldiers. During the past four years experiments have been made with all " possible and imaginable " kinds of punishment. Recently an order was issued by the Commander of the II. Division forbidding punishments " other than those sanctioned by the law." An Army Order on the subject goes even further; it directs that certain punishments, although recognized by the Swiss Regulations, are prohibited as they have become obsolete.

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The author of the original article is of opinion that since Guard Mounting is a " service of honour," it is a mistake to award " extra guards," as a form of punishment ; he thinks that one of the best punishments for minor offences is a reprimand, either in public or in the orderly-room, according to the gravity, or otherwise, of the wrong-doing. Of course, in the case of serious offences detention must be resorted to. It is pointed out that when it said of a Chief : " He is severe, but just," he really receives high praise indeed. Regret is expressed in the original article that the Swiss Regulations do not mention " rewards " ; at the same time, it is admitted that the highest form of reward consists in the *satisfaction* of having performed one's duties. However, there are, in Switzerland as elsewhere, those whose efforts would be stimulated by the prospect of some material reward. The author of the original article states that he is not raising the question of reviving the distribution of " ribbons, crosses, medals and other honorific distinctions of which our neighbours make bountiful use," but rather the question of discovering some means for increasing the soldier's pride in his uniform, in reviews and ceremonial matters, etc.

Certain distinctive badges have already been introduced into the Swiss Army, and the question is asked whether it would not be possible to reward good and faithful long service by an increase of pay, by some special record in the soldier's service book, or by the grant of some other distinction ?

Examples are given in the original article of the directions in which new forms of reward may be sought for the Swiss Army.

The Browning Machine Gun and the Browning Machine Rifle.

Short descriptions are given in the original article of the Browning Heavy Machine Gun and the Browning Machine Rifle adopted by the American Army.

The Heavy Machine Gun (model, 1918) is of the water-cooled type and is mounted on a tripod. It is of extremely simple design ; the breech piece consists of five separate parts only. During certain trials, 39,500 rounds were fired from one of these pieces without a hitch ; on another occasion 20,000 rounds were fired in 48 min. 16 secs., with three miss-fires only (due to defective cartridges). The ammunition is fed to the gun by bands each carrying 250 rounds. Eight men normally form the gun-team, but it can be served by two men and even by a single man in an emergency.

The total weight of the gun (without tripod) with filled water-jacket, is $34\frac{1}{2}$ lbs.

The Machine Rifle (model, 1918) is air-cooled. It can be used either as a semi-automatic or an automatic weapon. It weighs about 15 lbs.

The Machine Rifle can be fired either from the hip or from the shoulder. When used as an automatic weapon, it can fire 20 rounds in $2\frac{1}{2}$ seconds ; and 350 rounds can be continuously fired before the barrel becomes so hot as to necessitate a rest.

The Machine Rifle can be rapidly manufactured in very large numbers.

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NOTES AND NEWS.

Switzerland.—The contributor of the original Notes states that the year 1918 ended sadly but nobly for the Swiss Army. Before being demobilized, on the termination of hostilities on the borders of Switzerland, the Swiss Army paid its toll; it was called upon to make sacrifices, which might have been avoided had those, who are demanding Helvetic liberty, properly understood their duty towards liberty. The general strike was a sorry spectacle, being a callous exhibition of ignorance and unreasoning hatred on the part of the ring-leaders of the Soviet movement.

It is customary for promotions in the Swiss Army to be gazetted at this period of the year. It is announced that Divisional-Colonel L. H. Bornand, has been promoted a Corps Commander and has taken over the I. Army Corps from Colonel Audeoud; Colonel Ed. de Meuron has succeeded, in consequence, to the command of the I. Division. Divisional Colonels F. Brugger and R. Weber have also been promoted to the rank of Corps Commander.

General Wille has retired from the Command-in-Chief of the Federal Army and, in consequence, the Federal Council has resumed control of the Headquarter Administration of the Swiss Army.

The Budget proposals for 1919 prepared by the military authorities provided for war conditions; it has been remitted by the National Council to the Executive for revision, so that it may be reduced to comply with the requirements of peace service.

Attention is called to the announcements which have appeared in the British Press that the British Government was contemplating the abandonment of Compulsory Service. The question is put: Does this imply that we are within measurable reach of the date when all armies will be abolished? If so, the members of the future "League of Nations" will find themselves (the author of the original Notes points out) in a somewhat helpless position should one of their number suddenly decide to settle its quarrels with another by an improvised armed force. It is not in pacifism that the danger of belligerency lies, but in the pacifists; they are "the most redoubtable artisans of War."

It is stated that in consequence of the publication of the Report of Count Lerchenfeld, the Bavarian Minister at Berlin, showing the part played by Germany in the ultimatum of 23rd July, 1914, sent by Austria-Hungary to Serbia, Lieut.-Colonel Frey sent a postscript to his letter of November last (*vide R.E. Journal* for January, 1919, p. 31), which arrived too late to be acted upon. In this postscript Colonel Frey appears to have made the request that his letter to the Editor should not be published; he further expressed the opinion that "When the contents of the archives of the *two camps* are made public, it will come to be recognized that the World War *must* have broken out sooner or later. The responsibility for its outbreak rests on the shoulders of all those Statesmen who pursued the aims of the so-called *Realpolitik* in accordance with historical traditions, as opposed to the course adopted by Wilson, who has realised his pacifist ideas by the sword."

The sophism of the "preventive war" to which Germany had recourse for the purpose of excusing her responsibility as the agressor,

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when it became impossible for her to deny that she took the initiative, will be readily recognized in the above extract. The evidence which has been produced as to the intentions of Germany so clearly indicate her designs that it is now useless to fall back on this sophism for an excuse. The unconvincing tenour of Colonel Frey's communication and its inconsistencies are fully dealt with in the original Notes.

International Notes.—The final phases of the Great War are briefly touched upon under this heading ; the events between the 1st September and the 28th October last, when the German resistance between the Aisne and Oise was definitely broke down, are recorded in outline.

Franchet d'Esperey's offensive in the Balkans, resulting in the capitulation of Bulgaria in September last, and the retreat of the Austro-Germans in October last are referred to as also the British successes in Palestine in the same months. The events in Italy and in France leading to the armistices with Austria-Hungary and Germany in November last are also mentioned.

Portugal.—A special correspondent deals in a short contribution, with the situation arising in consequence of the Armistice with Germany. The Portuguese seem to think that the former German Empire will be replaced by an agglomeration of small independent States. They desire to see Poland reconstituted as a European State.

Some doubt seems to exist, in the mind of the contributor of the original Notes, as to whether Alsace-Lorraine will become an integral part of France, or whether it also may not form a new State, taking its place, in the future, as an independent Member of a " League of Nations."

It is recognized, in Portugal, that the *Mittel-Europa* scheme is now completely dead. It is expected that the killing of this monstrosity will render it possible for some of the smaller States to acquire a " window by the sea."

The question of dealing with Germany's lost colonies presents difficulties ; an *International Confederation* of these Colonies under a mixed Government nominated by the " League of Nations " is suggested as a possible solution of the problem.

Since Germany had kept the rest of Europe on tenter-hooks for the past 40 years, considerable relief is felt in Portugal at her crushing defeat. And the Portuguese, in view of the barbarous and cruel methods used by the Germans in waging war, are not in favour of a peace based on the formula, " No compensation, no indemnities " ; further they wish to see the utmost penalty permitted under the *lex talionis* inflicted on all who may be convicted before a legally constituted International Tribunal for crimes committed by them against the usages and customs of civilized war.

United States of America.—A special correspondent writes that the soldierly spirit, the bravery (bordering on rashness) and the discipline shown by the young American troops have created a most favourable impression in Allied circles. There should have been no cause for surprise in the matter, as a reference to the history of the American Army clearly proves that American soldiers have at all times exhibited the characteristics whereof mention is made above. That the Germans

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experienced an unpleasant surprise, in relation to the value of the new American Army, can be accounted for by the fact that, in spite of their much vaunted knowledge, they are poor students of history and of psychology and, in consequence, failed completely to appreciate the inner meaning of the forbearance of their neighbours in the face of their overbearing and arrogant manners in the years preceding the Great War.

The Teutonic military sagacity may have been able to assess the value of the Russian Army at its true worth and to discount the helpless position of Roumania. It may even have correctly forecasted that Italy would eventually throw in her lot with the Western Allies, but it is quite evident that it was woefully wrong in its estimate of the value and extent of the American effort ; the three fatal errors in the German calculations consisted in the assumption that :—

1. America had neither the means nor the time to raise a sufficiently large Army. It was expected further that the German U-boats and the deficiency of transport would prevent any part of the American Army reaching Europe.

2. The insufficiency in numbers and the lack of training in the American Army would be so great that, even if a part of it were to be successfully landed in Europe, this Army would have to be kept in reserve for so long a time as to have no appreciable influence on the military situation on the Western Front ; and

3. Lastly, owing to the opposition of the American people to conscription, the Government of the United States of America would not be able to raise an Army having any practical value.

The Great War has taught the German people a great many lessons, but perhaps none of them excites more bitter resentment than the knowledge that they totally misunderstood the American nation and its rulers.

INFORMATION.

Attention is called to an official communication (in French) issued from the Adjutant General's Department, Berne, relating to soldier's boots, wherein errors in spelling occur, as well as in the expressions used.

A letter on military aviation from M. Schleppy, a former Commandant of the Aviation Group, is published in the *Revue* under notice ; it deals with certain matters connected with the design of aeroplanes referred to in the article on " The Re-organization of the Swiss Aviation Service " which appeared in the number of the *Revue* for October, 1918 (*vide R.E. Journal* for December, 1918).

This number of the *Revue* concludes with a *Bulletin Bibliographique ;* notices relating to several works dealing with various aspects of the Great War appear therein.

W. A. J. O'MEARA.

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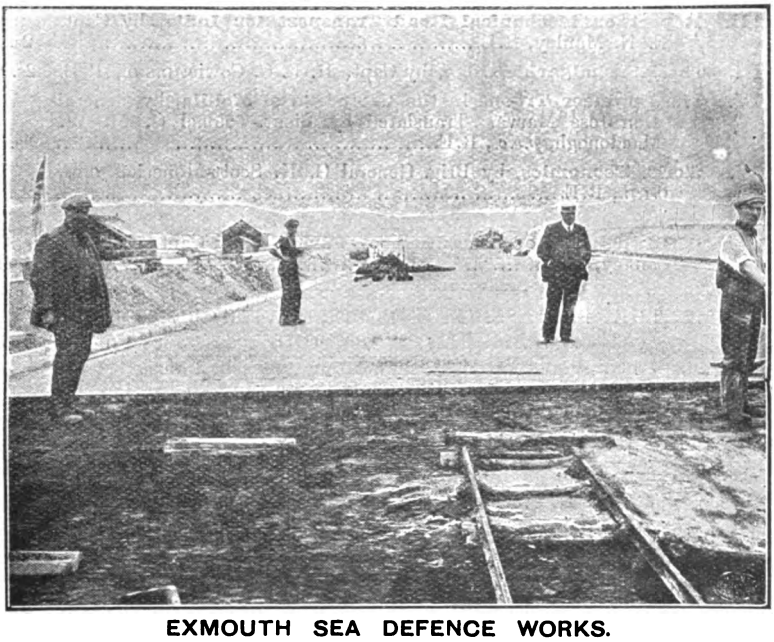

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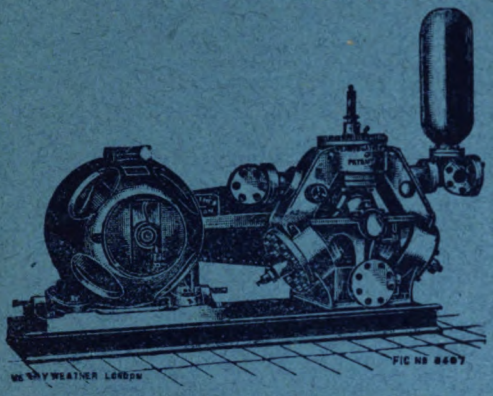

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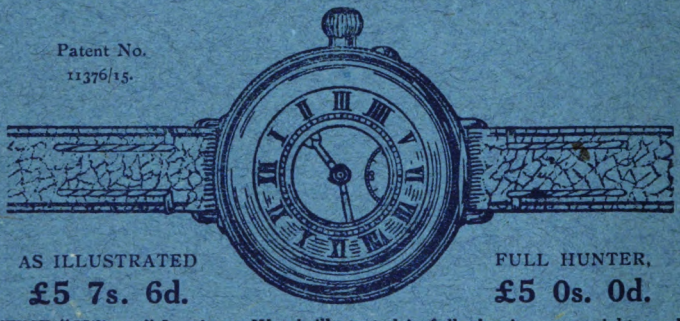

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(*a*). Lieut. Marsland, 1 N.C.O., and 3 other ranks at Piccadilly Exit to assist Infantry, with orders to close exit by means of charge fixed in side of gallery for that purpose, should the enemy attempt to enter in force.

(*b*). Capt. Walker, 1 N.C.O., and 6 other ranks at Moat Farm entrance to assist Infantry.

(*c*). One N.C.O., and 4 men in Givenchy Keep dugout system to act as guides and maintain liaison between garrisons in Givenchy Keep and Mairie Redoubt.

(*d*). Lieut. Rees and remainder of Tunnellers to man No. 4 Shaft Penthouse and the Sap leading thereto, this being an excellent position from which to protect north side of Caledonian Road Penthouse and Moat Farm entrance.

These dispositions were approved by Colonel Evans, 1st Battalion, Black Watch, on evening of 17th April.

About 7 a.m. enemy shelled Givenchy Ridge, but especially vicinity of Caledonian Road exits and Moat Farm entrance very heavily, advancing to the attack in great strength. One officer Captain of

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the Black Watch with 15 other ranks, reached Piccadilly Trench through Bunny Hutch Subway, but were overwhelmed with the exception of 3 other ranks, who escaped to Caledonian Road dugouts, badly wounded, at 8 a.m. After this, the defence of Piccadilly Exit devolved on Lieut. Marsland and 4 other ranks, R.E. They held position by rifle fire until there was danger of them being overwhelmed, when Lieut. Marsland fired the demolition charge and closed the exit. The long stretch of Subway, west of the Piccadilly Exit was then commanded by a Lewis gun posted at a turn in the gallery. Meanwhile, at Moat Farm entrance, a Captain of the Black Watch, O.C. Co., was holding the surface approach and as the garrison in Caledonian Road Penthouse was in difficulties, he organized an attack against the enemy in vicinity of that point to relieve the pressure. He was killed in the attack which recoiled. Capt. Walker, R.E., immediately re-organized the attack, and led remnants of the Black Watch from the Moat Farm entrance in an easterly direction against Caledonian Road. While so doing he sustained a wound, fracture of shin bone, from M.G. fire, which put him out of action. The attack failed, and Capt. Walker was assisted into the dugout system by Sergt. Newell, R.E., about 9 a.m. From this time, apparently the Tunnellers were the sole guard of Moat Farm entrance. They were ultimately beaten back from the stairway near the surface by bombs, and retreated behind the gas door, where they erected a barricade of sandbags, from behind which they fired their rifles thus denying entrance to the enemy.

Going back to the hour of 7 a.m., the first attack of the enemy, advancing southward from Festubert flats, was apparently beaten off, whereupon he retired and subjected Caledonian Road Penthouse Shelter area to an intense bombardment by Heavy How. Shell (estimated at 8 ins. or 10 ins. diameter). This knocked out those of defenders who were manning the trenches—one platoon of 1st Black Watch was wiped out by one shell. About 12 Tunnellers, who were endeavouring to dig out the few survivors, were knocked out within two minutes by another shell. This action of the enemy had the effect of disorganizing the surface defence of the penthouse shelters, those who remained on top of shafts being bombed down below into the deep dugout system. All penthouse shelters, with exception of No. 4 (never used by Infantry garrison), were at this stage in the enemy's hands. Sapper Turner continued to hold the sap approach to No. 4 Shaft Penthouse till about 1 p.m. He was assisted by Sapper Stewart who loaded while Sapper Turner fired. Lieut. Rees superintended this part of the defence. All surface defence of the Caledonian Dugout Penthouse Shelters ceased about 10.30 a.m., with the exception noted above. The action taken below ground by the Tunnellers was to build sandbag barricades at the bottom of

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stairways of Shafts Nos. 1, 2 and 3. These were manned by composite parties of Black Watch and Tunnellers.

This brings the history to about 10.30 a.m. From that time to 1 p.m. the enemy continued to throw bombs down all entrances in their possession except Piccadilly Exit, which had been effectually blocked by the blow. Both Sergts. Newell and Menadue report that the enemy used gas, either in bombs or spray, and threatened to use it in quantities unless the garrison surrendered. This apparently decided the officers, both Infantry and Tunnelling, to surrender on account of the large number (estimated at 70) of wounded men lying around the tunnels. Capt. Walker, though wounded, urged a policy of no surrender. After a parley, the surrender was arranged about 2 p.m. About 1.30 p.m. Sergt. Newell had gone to the top of No. 4 Shaft and accompanied by Sapper Turner had reconnoitred the surface in that vicinity, finding no enemy, though they could be heard talking in Caledonian Trench near by. On Sergt. Newell's return to communicate information obtained, he found three enemy officers in charge of dugouts ordering the removal of the garrison. All N.C.Os. were ordered under pain of death to precede other ranks up No. 3 Shaft. In spite of this, Sergts. Newell and Menadue decided to stay with Capt. Walker, he being a stretcher case, could not be evacuated through a spiral stairway. Lce.-Corpl. Morgan decided to take his chance in hope of escaping by lying hid in the engine room off Bunny Hutch Subway. On orders being received from the enemy officers to evacuate Capt. Walker through Moat Farm entrance, Sergts. Newell and Menadue constituted themselves his stretcher-bearers, and accompanied by Sapper Turner and another sapper left the Subway by Moat Farm entrance. Finding the way clear, they decided, after consultation with Capt. Walker, to endeavour to escape to Ponte Fixe, which they succeeded in doing safely. Before leaving the Moat Farm entrance, they called to some men standing by in the subway to come to the surface and escape with them. Only three sappers availed themselves of the chance and escaped safely, also Lce.-Corpl. Morgan lay *perdu* for some two hours and escaped by the same route.

Meanwhile there had been heavy fighting in the vicinity of Givenchy Keep. Of the five Tunnellers assisting this garrison, Corpl. Knowles and 1 other rank were killed and 2 other ranks wounded, only one sapper returning to billets. I was in Givenchy Keep on 20th April, and was informed by the O.C. Keep that our men had put up a stout fight.

Total casualties in the fight were :—

Killed.—3 other ranks.

Wounded.—Capt. Walker and 2 other ranks.

Wounded and Missing.—5 other ranks.

Missing.—Lieuts. Rees and Marsland and 20 other ranks.

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55TH DIVISION.

I. Corps.

I should like to bring to notice the excellent work done by the 251st Tunnelling Co., under Major Church, and the Australian Electrical and Mechanical Boring and Mining Co., under Capt. A. J. Auret, during the recent operations about Givenchy. The 251st Tunnelling Co. took part in the defence of Givenchy which, during the 9th April, the initial day of the German attack, was overrun by the enemy. The arrangements made by them for the defence of the mined galleries and dugouts enabled a very effective counter-attack to be made from the latter. In addition the whole of the details who were not below ground took part in the fighting on top, and a detachment of them which was at rest and was put under my command, enabled me to strengthen my very extended left flank, which reached westward to the Lawe Canal, and by occupying trenches near this canal for several days were instrumental in preventing the enemy from overlapping or penetrating.

The pumping and lighting of the galleries and dugouts were in the hands of the Australian Electrical and Mechanical Boring and Mining Co. The danger to which this plant was exposed in the event of serious attack was represented by me some time ago, and application made for the installation of an effective plant below ground to replace or reinforce that at Pont Fixe, from which power for pumping and lighting had to be carried by a cable overground for 1,000 yards. I was, however, informed that no action of this sort was possible, and that it was not deemed necessary. There was a small auxiliary plant in the galleries, only sufficient to keep the dug-outs habitable for about four days, and of doubtful reliability. Had it been impossible to keep the pumps running the garrison would have been drowned out in a few days. During the eight days that the Division held Givenchy, subsequent to the German attack on the 9th, the cables were cut repeatedly by the intense shelling. But in spite of all difficulties, the Australian Electrical and Mechanical Boring and Mining Co. succeeded in keeping both lighting and pumping machinery going up to the time that we were relieved, thus materially assisting the defence by allowing troops to be kept under cover where their presence was required.

H. S. JEUDWINE, *Major-General,*
Commanding 55th Division.

55th Division Headquarters,
April 17th, 1918.

3RD AUSTRALIAN TUNNELLING COMPANY.

Report on Operations No. 1 Section from 9th—18th April, 1918.

I have to report as follows on the operations of No. 1 Section of 3rd Australian Tunnelling Co. from the 9th to 18th inst.

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April 9th.—Heavy enemy bombardment commenced on 8th and lasted all night (8th to 9th gas and H.E shells, very heavy on right). Rumoured that enemy had broken through our line at Laventie. At 8. a.m. the day relief of 19 other ranks went to work as usual, Lieut. Campbell with them. At 3.30 p.m. I stopped the 4 p.m. relief from going to work. Acting on instructions received from Lieut. Campbell I telephoned the C.R.E., 34th Division, for orders at 4 p.m. Ordered to report to 101st Brigade at once. Lieut. Campbell returned with off-coming relief at 4.30 p.m. I fell men in with full kit, 48 hours' rations, two officers and 38 other ranks in party. Marched to assembly point, No. 3 Series M.G. emplacements whilst Lieut. Campbell reported to 101st Brigade per motor bicycle. Lieut. Campbell was ordered to report with party to 102nd Brigade at Erquinghem; marched men to Erquinghem, and reported to 102nd Brigade at 7 p.m. 102nd Brigade ordered us to report back to 101st Brigade Marched men back to No. 3 Series emplacements (very heavy shelling on both marches) and again reported to 101st Brigade at 8 p.m., who ordered us to again report to 102nd Brigade. Lieut. Campbell, self and four men went back to Erquinghem and reported to 102nd Brigade at 9 p.m., leaving balance of party in charge of Corpl. Barsby at No. 3 Series. G.O.C. 102nd Brigade ordered us to report to Major Osborne of 15th Royal Scots Regt. Did so and sent runners back to Corpl. Barsby and party; when party arrived at 11 p.m. Major Osborne told us to report to Lieut. Young (Company Commander) who showed us a position and ordered us to dig in. This position was facing S.W. on the right flank of and at right angles to the front of the X Battn. (A composite battalion of pioneers, engineers, 18th N.F., and attached infantry.) Lieut. Young told us we were behind the reserve line. Posted sentries and stopped there all night. Apparently no one on our right flank.

April 10th.—Erquinghem heavily shelled until 1 a.m. 10th. Stood to at dawn. About 7 a.m. enemy appeared to be advancing—our right flank still in the air. Reported this to Lieut. Young. At noon enemy seen crossing our front from left to right about 600 yards away. Right flank still unprotected. Again reported this and sent out patrols to get in touch with our nearest troops. Patrols reported a gap of 200 yards between us and some pioneers. Patrolled gap myself and found it to be as reported. Lengthened our line to try and link up. Enemy getting closer, opened fire at 400 yards. At this stage a German was seen crossing our front about 900 yards away. Sappers No. 5786 J. Muir, No. 5858 J. A. Watson, and No. 4434 J. Nunn-Pendle, stalked him and took him prisoner. An officer then reported that a battalion of Royal Scots (?) was coming to reinforce and fill the gap reported. Met the officer and showed him the position. Another battalion (?) came up and took up a position parallel to the railway line and on our left flank. Enemy

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came nearer and occupied a farm in front. Heavy enemy machine gun and rifle fire 6 p.m. Very heavy short-range fire from enemy light artillery. Lieut Campbell now put in command of the company of the X Battn. to which we were attached, in place of Lieut. Young. At 7.30 p.m. Lieut. Campbell received written orders from C.O. X Battn. to retire and report to Colonel Stephenson, 16th Royal Scots. at Jesus Farm. Corpl. Barsby states that as the runner with this order came along the line, he called out to the men—" Jerry is over the Canal, get back quickly." Although I did not hear this personally the statement has been corroborated by several men of the detachment. A number of men then retired without orders. Lieut. Campbell did not seem satisfied and told me to hang on, while he saw about it. He then walked towards Headquarters and was lost to view behind a burning estaminet. He was not seen afterwards by any of the party. Both companies on our flanks then retired and I ordered my company to retire in conformity. During retirement Sapper Kelly was hit and fell—believed to be killed. Enemy were then very close and enemy machine gun, rifle and artillery fire very heavy. Took Sapper Ashford and went to Battalion Headquarters (15th Royal Scots) to look for Lieut. Campbell, found Headquarters deserted. Picked up Corpl. Barsby and 29 other ranks at rendezvous and reported with them to Jesus Farm at 8 p.m. Balance of party missing. Looked for Colonel Stephenson and found Colonel Lloyd of 12th Suffolk Regt., 40th Division who took charge and posted us on left of Wigan Post. Called roll. Lieut. Campbell and the following other ranks were missing :—Sappers 6891, G. F. Burke, 5858, J. A. Watson, 6668, F. H. Brownhill, 1057, E. Kelly (believed killed), 4518, D. R. Wilson, 6876, C. W. Cook, 4808, A. G. Yaxley.

April 11th.—Stood to till 2 a.m. then fell in and marched to Nieppe, still under Colonel Lloyd's orders. Arrived Nieppe at 3.30 a.m. Called the roll and found Lce.-Corpl. Mayne, Sapper Ahern and Sapper Roberts missing. Rested till 5 a.m. ; fell in and marched to mill off Armentiéres-Ballieul Road. Dug in here. At noon ordered to fall in as platoon attached 12th Suffolks. Marched across main road and took up position. About 1 p.m. advanced as a wave in support of 12th Suffolks to hold enemy. South Wales Borderers (?) forward on left front twice retired and were collected and sent back by Sergt.-Major Macey of 12th Suffolks and myself. Lay out all day in field under fire. M.G. and snipers very active. No. 4765, Sapper A. W. Hogan sniped through left breast. At dark (8.30 p.m.) 12th Suffolks retired as ordered through my position and my platoon covered retirement and followed on as rearguard, in accordance with instructions from Colonel Lloyd. We marched towards Bailleul and rested for a few hours on Bailleul Road.

Called roll : Three sappers missing. Fell in at 5 a.m. and marched

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to Strazelle. Rested till 3 p.m. After thanking the men for the support they had given, Colonel Lloyd ordered me to report with my party to 1st Australian Brigade Headquarters at Pradelles, did so and bivouacked with Australian L.T.M. Battery.

April 13th.—Brigade Major 1st Australian Brigade ordered me to report to 1st Field Co. Australian Engineers at Borre under Capt. B. Dowling, did so and rested that day.

April 14th.—8 a.m. marched to forward billets 1st Field Co. Australian Engineers at Pradelles; men attached to Nos. 2 and 3 sections 1st Field Co., worked on Strazeele defence and spitlocking and digging trenches. Heavy bombardment of billets. Sent report by D.R.L.S. to O.C., 3rd Australian Tunnelling Co. stating position, nominal roll, and asking for orders.

April 15th.—Reconnoitred positions for charges to mine roads at Strazeele, Section Bois, and Railway.

April 16th.—Excavated for above; no explosives to complete charging.

April 17th.—Digging strong points and alarm posts. Heavy enemy shelling. At 8 a.m. orders received from O.C., 3rd Australian Tunnelling Co. to meet transport at Wallon Cappell at noon of 18th, to rejoin unit.

April 18th.—Fell in at 8.30 a.m. and marched to Wallon Cappell. Met lorry from 3rd Australian Tunnelling Co. Picked up Corpl. Mayne and 8 men at Ebblinghem. Arrived at Headquarters 3rd Australian Tunnelling Co. at 6 p.m.

The following is a nominal roll of the party at 4.30 p.m. on 9. 4. 18 :—

Lieut. N. Campbell, Lieut. J. Dow, 1251, Corpl. S. Barsby, 4395, Lce.-Corpl. E. Mayne, 5616, Lce.-Corpl. W. S. Stubbs, 910, Sapper R. T. Ahearn, 6688, Sapper F. H. Brownhill, 922, Sapper A. C. Bennetts, 6891, Sapper G. F. Burke, 4537, Sapper W. E. Burke, 4277, Sapper W. Bunning, 4746, Sapper G. Cahill, 6878, Sapper C. W. Cook, 6765, Sapper W. G. How, 4765, Sapper A. W. Hogan, 5337, Sapper F. G. Hanson, 1057, Sapper E. Kelly, 5363, Sapper C. H. Leaver, 4419, Sapper A. McLean, 4422, Sapper T. D. McLean, 1223, Sapper E. Marsh, 5786, Sapper J. Muir, 4434, Sapper J. Nunn-Pendle, 2395, Sapper S. Novok, 1215, Sapper J. Peach, 5819, Sapper T. Ritter, 6643, Sapper T. Ryan, 4462, Sapper W. Roberts, 4843, Sapper A. V. Symons, 1237, Sapper J. T. Smitheram, 4518, Sapper P. R. Wilson, 4516, Sapper J. Wilson, 5858, Sapper J. A. Watson, 1200, Sapper W. Williams, 4808, Sapper G. Yaxley, 1247, Sapper S. F. Ashford, 4282, Sapper S. Browne, 5794, Sapper P. McManus, 2891, Sapper D. N. Blizzard, 4511, Sapper H. Williams.

The behaviour of the detachment under trying circumstances was splendid. Their coolness and steadiness under heavy fire was

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admirable. Their conduct, whilst acting as a covering screen in the retirement on the night of the 11th was worthy of the high traditions of the British Army. In this connection I should like to bring to your special attention the names of No. 1251, Corpl. Barsby, No. 4537, Sapper W. E. Burke, and No. 5794, Sapper P. McManus. Corpl. Barsby was coolness personified, and by his steadiness and devotion to duty gave me the greatest assistance. He commanded the second line of my platoon on the 11th, and handled it with courage and initiative. When Sapper Hogan was wounded, Corpl. Barsby, with Sapper How (No. 6765) went to his assistance, and dressed his wound at great personal risk. Nos. 5794, Sapper P. McManus and 4537, W. E. Burke, on all occasions by courage and cheerfulness encouraged the rest of the detachment. It is with very great regret that I have to report :—

Lieut. N. Campbell, missing.

No. 1057, Sapper E. Kelly, missing (believed killed), No. 4765, Sapper A. W. Hogan, wounded (G.S.W. in chest).

19. 4. 18.

C.R.E. 38TH DIVISION, C.E. VTH CORPS, C.E. THIRD ARMY.

C.E. Vth Corps.

Reference your No. E.6820/129 dated 27. 10. 18 the following are the principal bridging feats of the units under my Command during the crossing of the river Selle between Montay (inclusive) and Neuvilly (exclusive).

(1). These came under four headings :—

(*a*). Footbridges.
(*b*). Tank Crossing.
(*c*). Artillery Bridges.
(*d*). Heavy Bridges.

(*a*) and (*b*) had to be completed before Zero ; (*c*) and (*d*) were not required until after Zero. Zero was 0200 hours, 20. 10. 18.

(2) (*a*). *Footbridges.*—On taking over from 33rd Division 11 light pontoon bridges were in position, 2 footbridges were taken over from 66th Division, on the Right Boundary of 38th Division being moved South East. At least 24 footbridges were required before Zero. Additional cork float footbridges were put across on the nights 17th-18th and 18th-19th October, and at Zero there were 28 footbridges. Owing to damage by shell fire some of the bridges had to be repaired several times. The work was done by 123rd Field Co., R.E. (Major Pressey, M.C., R.E.) and 151st Field Co., R.E. (Major Borns, M.C., R.E.). The enemy was close, and the nights were very light.

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(*b*). *Tank Crossing* was constructed of sleeper crib work threaded on vertical iron rods, without any roadbearers or decking. This new type was suggested by 11th Tank Battalion. Details were sent to you on 23.10.18 under my No. R.E. 5712. The work was done by 123rd Field Co., R.E., Lieut. Doyle being actually in charge of the job. It involved working breast deep in water for several hours under shell and M.G. fire, and the enemy's flares were falling within 20 yards of the site one night. The bulk of the work was done on the night 16th-17th October, improvements being carried out the two following nights. It was a complete success and enabled the Tanks to cross for the attack.

(*c*). *Two Artillery Bridges* were to be put over by 123rd Field Co., R.E. as soon after Zero as possible. One medium pontoon bridge was constructed, but the work was delayed as nearly 50 per cent. of the party became casualties. Two sections of 151st Field Co., R.E. were therefore placed under the orders of O.C., 123rd Field Co., R.E., and a second medium pontoon bridge was built. The tank crossing was also decked, etc., to take field guns.

(*d*). *Two heavy bridges* were built. The first was done by 212th Field Co., R.E. (Major Anderson, M.C., R.E.) of 33rd Division, which was placed under the orders of C.R.E., 38th Division for the work. The bridge was one 30-ft. span reinforced for tanks. The bridge stores were only handed over by XII. Corps (which was originally to have done the work on 19th October). On the morning of 20th the necessary measurements of the gap were made under heavy shell fire. Work was started 1245 hours and was completed next day (21.10.18) at 0845 hours, delay having been caused by shelling. The other heavy bridge was done by 124th Field Co., R.E. (Major Brazel, M.C., R.E.). It was a two-span bridge for Tanks supported in the centre on a sleeper crib pier, the roadbearers being 22-ft. R.S.Js. The stores having been delivered some days before 20th at a bridging dump, very careful and complete preparations were made. Measurement of the gap was done under very heavy shell fire on the morning of the 20th. Work was started at 1315 hours and was completed (except for improvements to the approaches) by 1630 hours next day (21.10.18). The improvements to the approaches were completed by 1750 hours 21.10.18. There was further very heavy shelling of the site during this period.

(3). The work was rendered very difficult and dangerous by the following conditions :—

(*a*). The approaches to the river were down long open slopes, subject to shell and M.G. fire. Even after the attack the road to Montay was under enemy observation.

(*b*). The nights prior to the attack were very light.

(*c*). The enemy was very close. On the night 16th-17th our posts were withdrawn behind the river on account of a gas projection.

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(*d*). There was a good deal of gas in the valley.

(*e*). On the morning of the 20th and again in the evening, the valley and approaches were very heavily shelled.

That all the bridges were successfully constructed under these conditions reflects the greatest credit on all ranks of the Field Cos. concerned.

T. E. KELSALL, *Lieut.-Colonel, R.E.*
C.R.E., 38th Division.

28. 10. 18.

XIII. CORPS.

Report dated November 7th, 1918.

The following is a report on work done by the special parties detailed from No. 2 Section, 182nd (Tunnelling) Co., R.E., to save bridges over the canal from being destroyed by the enemy.

Main Road Bridge and Lock at Landrecies.—The party consisting of 2 N.C.Os. and 9 men advanced with the first wave of the infantry as far as the western outskirts of Landrecies. At this point they preceded the Infantry a distance of 400 yards. When reaching the bridge the superstructure was blown and immediately the débris had fallen the garrison which consisted of about 20 men, was rushed, killing two and taking 14 other ranks prisoners, thereby saving any further damage being done. All wires, etc., were then cut and charges removed. In addition, the party at the request of the Co. Commander of the Infantry, constructed a bridge over the Rivierette River to allow the men to cross.

One N.C.O. and 2 men advanced with the first wave of the infantry, and were successful in saving the wooden bridge. They removed the charges and rendered the bridge fit for traffic.

Three men advanced with the infantry and found that the footbridge had not been mined by the enemy.

NARRATIVE OF OPERATIONS BY 150TH FIELD COMPANY, R.E.

13th—21st October, 1918.

In the operations carried out by the II. Corps commencing on the 14th October, 1918, the 150th Field Co., R.E., was attached to the 109th Infantry Brigade, and the following special tasks were allotted to the unit :—

(1). To assist the assault waves to cross the Heulebeeke by placing light infantry bridges across.

(2). To carry out any necessary repairs on the roads in the area to be captured by the Brigade, with especial reference to the bridges over the Heulebeeke at Moorseele, Gulleghem, and Heule. Preparations were completed by the afternoon of the 13th October, the

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Company being organized on the following basis :— No. 1 Section, under 2nd Lieut. C. L. Knox, V.C., R.E., and one wagon attached to the 1st Battalion, Royal Innis. Fusiliers, for the purpose of carrying forward infantry bridges; No. 2 Section, under 2nd Lieut. R. Charlesworth, R.E.; No. 4 Section, under Lieut. W. M. W. Brunyate, R.E., each with a specially loaded bridging wagon attached in readiness to repair any craters or other gaps in the Moorseele-Heule Road.

Fighting transport, consisting of above-mentioned wagons, a trestle wagon loaded with 15 ft. of superstructure and spare timber, and a double tool cart were all under the general control of Lieut. J. B. Stapylton-Smith, M.C., R.E. At 1900 hours on the 13th, 2nd Lieut. C. L. Knox, and No. 1 Section, moved off into battle position with the 1st Royal Innis. Fusiliers at Jago Farm. At 0330 on the 14th, Nos. 2 and 4 Sections, and fighting transport moved into a reserve position at Arkmoelen, arriving about 0500. Capt. A. Ferrier, R.E., and 2nd Lieut. R. Charlesworth, then went forward to 109th Brigade Headquarters at Bass Farm. 2nd Lieut. C. L. Knox, and No. 1 Section successfully bridged the Heulebeeke with the first wave, but the infantry bridges proving somewhat short, other crossings were constructed with local materials. Casualties were one killed, one died of wounds, four wounded. As the enemy carried out no demolitions to roads in the area captured by the 109th Brigade, the remainder of the unit was not called on to go into action. The whole Company, less horse lines, was concentrated on the night of the 14th, at Cohen House, and fighting transport at Oram Farm. On the 15th, the Company stood by for orders. Two pontoons, with wagons and teams complete, were attached to the 122nd Field Co., R.E., taking subsequent part in the bridging operations carried out by that unit on the 16th October, at Courtrai. On the 16th October, the Company moved to Ledeghem, and remained there until 1330 on the 18th, when it moved to Absul, with horse lines at Winkle St. Eloi. During the afternoon of the 18th, Capt. Ferrier and 2nd Lieut. Charlesworth visited the Headquarters of the 11th Belgian Infantry Regiment, from whence 2nd Lieut. Charlesworth went forward with a guide to gain information about the approaches to the Lys near Oyghem. Capt. Ferrier returned to Vlugery Farm and remained there all night in close touch with 109th Brigade. At 2220 on the 18th October, Lieut. Stapylton-Smith, and 2nd Lieut. Charlesworth with No. 2 Section went forward with two pontoons and placed them in concealment in Oyghem, in case an attack should be ordered at dawn of the 19th. At 0730 on the 19th, Lieut. Brunyate, went up to Oyghem and made a most valuable daylight reconnaissance of the Lys and its approaches. The information he gained, decided without a doubt, the site at which a bridge was subsequently placed. Just before dusk on the 19th, Lieut. Stapylton-Smith,

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and 2nd Lieut. Charlesworth, with two teams of horses and No. 2 Section went to Oyghem and collected the pontoons, and took them to a reserve position in a farm. In the meanwhile, Nos. 1 and 4 Sections, 2nd Lieut. Knox, and Lieut. Brunyate, with two trestle wagons, followed later by two pontoons belonging to No. 7 Pontoon Park, under Capt. Ferrier, moved into position at a farm. Having arrived at this position, Capt. Ferrier and 2nd Lieut. Knox went forward to gain touch with No. 2 Section and the pontoons, and also the 121st Field Co., R.E. on the river bank. Touch having been gained, 2nd Lieut. Knox returned to his Section. Capt. Ferrier remained.

During the night, O.C., 121st Field Company, R.E., asked for another pontoon, and Lieut. Stapylton-Smith, and 2nd Lieut. Charlesworth, with No. 2 Section brought the wagon down to the bridge under heavy shell fire and unloaded the boat. At this stage, one driver and five horses were killed in the farm. Word was received from O.C., 121st Field Co., R.E. at 0250 on the morning of the 20th, that the 107th Infantry Brigade had completely passed over the Lys. Instructions were accordingly sent to Lieut. Brunyate and 2nd Lieut. Knox, with Nos. 1 and 4 sections, to investigate the river bank and start bridging, if possible. The material was all brought down to the site, when these two sections came under shell fire, and were forced to scatter, one man being killed. At this time, owing to the situation on the left flank not being clear, orders were issued to stop bridging until later. Shortly after 0800 on the 20th, the situation on the left was reported clear, and bridging operations were again ordered to start. Capt. Ferrier and Lieut. Stapylton-Smith, having previously made a rough reconnaissance of approaches to the bank, a medium bridge was constructed, the first transport passing over at 1415. A certain delay was caused in the construction of the bridge, owing to the shortage of pontoons. During the 21st October, the Company was employed on maintenance of the pontoon bridge, construction of roadways, and a light footbridge.

NARRATIVE OF OPERATIONS ON 19TH AND 20TH OCTOBER, 1918.

Bridging of River Lys by 121st Field Co., R.E.

Three bridging wagons with complete bridging equipment, were moved up at 0300 hours and equipment unloaded and placed amongst farm buildings.

At 1900 hours Capt. Knox and 2nd Lieut. Delahey with Nos. 2 and 4 Sections launched the two pontoons and tied ropes on for towing. At 1925 hours the infantry arrived and three N.C.Os. and three sappers rowed the first two boat loads across the river and then stayed on the east bank to tow the boats across during subsequent

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trips. After two trips had been made, the enemy sent up flares and turned machine guns on the site of the operations. The remainder of the two Cos. of Infantry and the Machine Gun Sections were safely ferried across, in spite of heavy M.G. fire, and no casualties were sustained, all the men being ferried across by 2000 hours.

The building of the bridge was then commenced, Nos. 1 and 3 Sections being held in reserve. About 2100 hours the enemy put down a heavy barrage of H.E. and gas shells right along the river. A light bridge was constructed, using half pontoons, but it was found that the width of the river was 83 ft., which was 8 ft. more than was estimated beforehand. I decided to try and launch a trestle, and had the parts carried down and assembled on the river bank. The shells were falling very close and making work difficult. Before the assembling of the trestle was completed, a gas shell fell amongst the party, and killed four men and wounded several others. No. 1 Section was called on to get the wounded away, and No. 3 to take the place of the wounded men, as the 4 Sections altogether only mustered 73 men to commence with. Several men on the bridge head were also hit, and it was only the magnificent example set by Capt. Knox, 2nd Lieut. Delahey, and some others that the work went on whilst the wounded were still lying there. The shelling caused further delay, and as the infantry were nearly due, it was decided to draw on the reserve pontoons of 150th Co., instead of launching the trestle and so save time. Word was sent to Lieut. Stapylton-Smith, 150th Co., and he brought the pontoons down at the gallop, and the bridge was then completed. Three minutes later, the first platoon of the 1st Inniskillings arrived. The 109th Brigade crossed without casualties. At 0430, 20. 10. 18, the shelling again increased, and the bridge got a direct hit, which destroyed the superstructure of part of it, and damaged one pontoon. Magnificent work was again done, and the bridge repaired before the next Battalion was due to cross, viz., 0600 hours. At daybreak material was collected for the construction of a permanent footbridge, which was completed during the day, and has been very much used.

122ND FIELD COMPANY, R.E.

Report dated October 18th, 1918.

On the morning of the 16th October, 1918, it was arranged to bridge the River Lys at Courtrai. The 122nd Field Co., R.E. was detailed to throw the bridge across the river, while the Commanding Officer of the 9th Royal Irish Fusiliers made all arrangements for loading and covering parties, also for a smoke screen and trench mortar fire on selected targets. The artillery were also to co-operate by putting down a barrage on a high bank about 200 yards on the right front, but failed to do so.

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The smoke screen on the right was poor, but might have been sufficient, if the artillery barrage had been provided as promised. By 1230 hours, the pontoons were brought forward to within 30 yards of the river bank behind houses. The pontoons were unloaded, and all stores laid out in readiness under the shelter of a wood pile, by 1300 hours. At 1400 hours the smoke screen was put down, and the T.M. Batteries and Lewis guns opened fire on selected targets. By 1405 hours it was considered that the smoke screen was thick enough and bridging could commence. 2nd Lieut. J. J. A. Fagan, R.E. took the first party down to the river with a half pontoon, and launched it successfully. A Lewis gun team and three riflemen were ferried across in this, and a sapper party landed, who put in a rope anchorage. 2nd Lieut. Fagan superintended the further ferrying of Infantry until he was wounded. Meanwhile, 2nd Lieut. A. J. Towlson, R.E. had launched the next boat, and started bridging. All available infantry having been ferried across, the boat thus employed was brought into position to complete the bridge. It was now about 1415 hours. The shore baulks and last bay were got across from this boat, but the chessing was never completed, as No. 3 boat was by this time in a sinking conditon owing to M.G. fire. The infantry, who were on the far side, had dealt successfully with the M.G.'s. on the left, but the smoke screen was insufficient to mask the bridge from the M.G.'s. on a high bank 200 yards away on the right front. About one rifle section got across the bridge, but the far shore bay, which was not completed, opened up and owing to the sinking condition of one of the pontoons the bridge broke up. At 1410 hours 2nd Lieut. A. J. Towlson, R.E. had been killed, and 2nd Lieut. J. J. A. Fagan, R.E. wounded. Capt. E. A. Wheatley, R.E. then took charge of the whole situation, and carried on all parties until he was wounded about 1440 hours. At 1445 hours the M.G. fire was very intense, and 3 officers and 24 other ranks, including most of the senior N.C.Os. were casualties, so the bridging party was ordered to withdraw.

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THE ROYAL ENGINEERS OF THE IRISH DIVISION.

21ST MARCH—4TH APRIL, 1918.

By LT.-COLONEL R. F. A. BUTTERWORTH, C.M.G., D.S.O., R.E.

THE fighting troops of a Division are the Infantry, Artillery and Field Companies R.E. *vide* F.S. Regulations, Part I. (Operations).

In trench warfare this fact is often lost sight of, as from the nature of things, the Field Company sapper is looked upon as the builder of dug-outs, provider of trench-boards and revetting material, and the handy man of all trades in and out of the line. In the retreat, however, he comes into his own, and both works and fights, laying down shovel to pick up a rifle, and defending a bridgehead until it is his job to drop the bridge prior to retirement. In all phases of war it is his honourable task to assist the infantry and artillery in gaining and maintaining the advantage over the enemy, using, for this purpose, his technical skill and training as an engineer. But when chance offers, as in a withdrawal, he is happy to fight alongside the infantry, and great is his reward if he gains some meed of praise for his stout resistance in a village street, or for timely support at a critical moment.

The withdrawal of the Allied Armies under the concentrated and well-prepared attacks of the German forces delivered on 21st March, 1918, may well be said to mark the turning point of the great European War. Then it was that the German General Staff —calculating on our big losses in the Ypres and Cambrai battles of 1917—hoped to break the allied front, sever the British and French along the line of the Somme, and win the War before the Americans could effectively intervene.

Trench warfare was converted into open fighting and the change of tactics was destined to put into the hands of one or other of the opposing forces the opportunity of strategical combination hitherto impracticable.

The dogged retirement of the Third and Fifth Armies, the fine defence of the First Army at Bethune, and the gallant stand of the Second Army on the Scherpenberg-Mont des Cats position, though yielding a few miles of territory, laid the foundation of a victorious counter-thrust.

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Following close upon this the magnificent leading and fighting of the French about Rheims and Chateau Thierry, enabled Marshal Foch to set in motion a strategical combination which was to have far-reaching and decisive results.

The share taken by the 16th Irish Division in the March battles, (its early and desperate defence of Ronssoy village, and its subsequent fighting withdrawal, and recovery on the Hamel-Marcel-cave line), find its place in the official records and war diaries. It is the hope of the writer to place on record the work and action of the Royal Engineers of this Division during this period, both in appreciation of the work done, and gallantry shown, and also as a possible help to future students of Engineer work in a retreat.

The order of battle of the 16th Division on 21st March, 1918, was as follows :—

Division Commander.—Major-General Sir C. P. A. Hull, K.C.B.

R.F.A.—G.O.C. R.A.—Brig.-General C. E. C. G. Charlton, D.S.O. 177th, 180th, 189th, 277th Brigades R.F.A.

R.E.—C.R.E.—Bt. Lieut.-Colonel R. F. A. Butterworth, D.S.O., R.E. 155th, 156th, 157th Field Companies, R.E.

49th Brigade.—Brig.-General P. Leveson-Gower, C.M.G., D.S.O. 2nd Royal Irish Regiment, 7th Royal Irish (South Irish Horse), 7/8th Royal Iniskilling Fusiliers.

48th Brigade.—Brig.-General F. W. Ramsay, C.M.G., D.S.O. 1st Royal Dublin Fusiliers, 2nd Royal Dublin Fusiliers, 2nd Royal Munster Fusiliers.

47th Brigade.—Brig.-General H. G. Gregorie, D.S.O. 6th Connaught Rangers, 2nd Leinster Regiment, 1st Royal Munster Fusiliers.

16th Machine-Gun Battalion.—Lieut.-Colonel R. Le Butt, D.S.O.

11th Hants Pioneers.—Lieut.-Colonel B. E. Crockett, D.S.O.

DETAIL AND DISPOSITION OF THE DIVISIONAL ENGINEERS, 21ST MARCH.

155th Field Co.—O.C., Major E. I. Scott, R.E., T.F. H.Q. and 3 Sections—Villers Faucon. 1 Section—Ronssoy.

Left Brigade Sector.—157th Field Co.—O.C., Major P. F. Whittall, D.S.O, R.E. H.Q. and 3 Sections—Villers Faucon. 1 Section—Ronssoy.

Right Brigade Sector.—156th Field Co.—O.C., Major T. L. Holbrow, M.C., R.E. H.Q. and 2 Sections—St. Emilie. 2 Sections—Villers Faucon. In reserve.

Orders in case of attack.—O.'s C. Field Cos. were instructed to collect their units as far as the actual situation allowed, and man

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the village defences under the orders of the commander designated in the Divisional Defence Scheme.

155th Field Co. 157th Field Co.	Villers Faucon.
156th Field Co.	St. Emilie.

Horse transport, with technical wagons and stores, were to be parked clear of the village, pending further orders.

The Opening of the Attack.—The attack in the early hours of the 21st March came in the nature of a surprise; it had been long anticipated, but there were no special signs or final warning on the night of 20–21 March that the blow would fall next day.

The enemy barrage came down with almost perfect synchronism at 4.15 a.m., the battle lines, battery positions, and villages of Lempire, Ronssoy, St. Emilie and Villers Faucon being heavily shelled with H.E. and gas. All telephonic communication forward of Brigade Headquarters was at once destroyed.

A thick fog enveloped the whole area, a grey white darkness of the consistency of steam. Advancing under its cover the enemy early reached the southern edge of the Lempire-Ronssoy defences, where hot fighting took place. The two forward sections of 155th and 157th could not for the moment be extricated and fought under the orders of the O.C. Lempire defences. Later on they were withdrawn to Villers Faucon by Lieut. F. H. King (Royal Irish Regt., attached R.E.), Lieut. G. H. Baxter, R.E., having been mortally wounded while engaged at close quarters in the defence of the citadel.

After a severe struggle in which the gallant battalion of South Irish Horse was practically annihilated, and in which the 7/8 Inniskillings suffered very heavy casualites, the villages of Ronssoy and Lempire fell into the enemy's hands. This happened at approximately 11 a.m. and had the effect of turning our battle line from the south. A withdrawal to the Switch Line Epeny—St. Emilie became imperative.

Meanwhile the Left Brigade put up a fine fight, and held on tenaciously to the Malassise Farm position, where the gallant defence of the Dublin Fusiliers continued until late in the afternoon.

The 155th and 157th Field Cos., under the command of Major Whittall, who became O.C. Village Defences, manned the defences of Villers Faucon. They suffered some casualties through shellfire, including 2nd Lieut. N.C. Gornall who was killed while taking a message from the O.C. to one of his groups.

The 157th successfully evacuated its transport during a lull in the shelling, to the neighbourhood of Marquaix. Unluckily a big shell struck the harness room of 155th and a great part of the transport was consequently immobilized. However, by making several trips the greater number of the wagons were got clear of the village.

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156th Field Co., not being immediately required for the defence of St. Emilie, the O.C. reported to the Brigadier 49th Brigade, and was instructed to extend our line to the right and head off small parties of German scouts who were advancing with light machine guns in order to work round the flank of the St. Emilie position from the south. This was a task dear to Major Holbrow's heart, and he fought his company till late in the afternoon on the right, and did most useful service. He was ably backed up by his senior subaltern, Lieut. W. B.G. Whitehouse, and his C.S.M., H. Gates, until the former was unluckily killed by a machine-gun bullet.

156th Co. was relieved at 3 p.m. by the Munster Fusiliers and withdrew to a support position in rear of St. Emilie. Major Holbrow sent off an excellent sketch and tactical report timed at 5.5 p.m. which was the first reliable information of the situation on our extreme right to reach Division Headquarters.

The situation at nightfall of 21st March was:—16th Division Brown Line (Corps Line) just east of St. Emilie—touch on the right with the 66th Division who had fallen back behind Templeux-Gerrard. 21st Division still holding out in Epehy.

As regards the R.E., 155th and 157th had been withdrawn to the Green Line just east of Tincourt, having been relieved in Villers Faucon by the 2nd Leinsters—156th remained in support at St. Emilie.

After dark, Capt. J. Shelly, of 156th Field Co. ran some transport into St. Emilie, the outskirts of which were occupied by the Germans, and succeeded in removing all the officers' and men's kits and mess gear. Major Holbrow turned out his company again to assist the infantry to dig in, and succeeded in strengthening the railway cutting midway between St. Emilie and Villers Faucon.

During the night 21–22 March orders were issued for the withdrawal of the Division on the Green Line (Tincourt—Templeux—La-Fosse). The C.R.E. was instructed to improve the defences of the Green Line, using 155th and 157th Field Cos., and any infantry that were available.

The 7th Corps Cyclist Co. were sent up to strengthen the right flank of the line which rested on the Cologne river just south of Tincourt.

At daylight, work was started on deepening the Green Line which, in our sector was a spit-locked trench protected by three belts of good wire. The Cyclist Co. was employed in wiring the marsh from the Tincourt-Roiselle high road up to the river. Meanwhile the infantry withdrew from the St. Emilie position and came into line by noon on the Green Line. This line had a fine field of fire, and the further advance of the enemy was held up during the day. 155th and 157th remained in line and assisted in the defensive action.

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Earlier in the day 156th had a difficult retreat through Villers Faucon and were withdrawn to Doingt.

Divisional Headquarters moved that afternoon to Doingt, and during the night 155th was withdrawn from the line and joined 156th.

22nd March.—Divisional Headquarters moved at 7 a.m., *viâ* Peronne to Biaches, where Divisional Headquarters were established.

155th and 156th Field Cos. marched to Biaches and remained during the day in Div. Reserve. The infantry fell back, stubbornly resisting, from Tincourt *viâ* Doingt to Peronne, reaching the latter town in the late afternoon. Fighting took place throughout the day, and many tactical points were resolutely held, while the general retrograde movement conformed to the movement of the Division on the left flank.

Here 157th Field Co. distinguished itself in acting as part of the rearguard for the 49th Brigade. On approaching Doingt, which is a small village in the main road about three miles from Peronne, the enemy pressed the 49th Brigade very hard with the intention of making the passage of the Somme at Peronne a difficult operation.

157th Field Co., under Major Whittall, and two companies of 11th Hants Pioneers, under Major Hazard, fought a valuable delaying action in the village. It was realized that, by taking cover in the houses and enclosures, a stout fight could be put up against the enemy, whose principal weapons at the moment were rifles and machine-guns.

A house-to-house fight took place, and valuable time was gained for the extrication of the infantry. Major Whittall received a bar to his D.S.O. for this action, and there is little doubt that Major Hazard would have been similarly rewarded if he had had the luck to survive the retreat.

Capt. G. Howson, of the Pioneers, showed great initiative in the same action, but, holding too long on to a building, was surrounded and captured. However, he eluded his captors and rejoined his company later in Peronne.

The infantry crossed the Somme just before dusk, and took up a position covering the river approaches in and about Biaches. The Bristol Bridge on the Peronne-Amiens Road was blown at 6 p.m.

The road between Biaches and Herbecourt was now much congested with horse traffic and transport, and three enemy aeroplanes came over and machine-gunned it. It was, however, a timorous effort from a great height, and three or four men only were wounded.

During the night the infantry were withdrawn on relief by the 39th Division, and marched into bivouac between Herbecourt and Cappy, and Divisional Headquarters moved to Cappy.

157th was ordered to rejoin 155th and 156th Field Cos. west of Cappy, and reached that village at 3 a.m. on the 23rd. The men

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were in splendid spirits, and were singing as they went through, in spite of having continuously marched and fought since 7 a.m. on the 22nd.

23rd March.—A day of most brilliant sunshine which the Division spent in support. The Field Cos. were ordered to fill up with S.A.A. and be ready to move at half-an-hour's notice. News was very scarce, but the general impression was that the Fifth Army were standing on the line of the Somme, and that the Division would soon be on its way again into line east or north-east.

Towards the afternoon, however, it was evident that the enemy was pressing forward on the north bank of the Somme, as the artillery fire was increasing momentarily in that direction.

At about 3 p.m. the Divisional Commander issued orders that bridgeheads were to be prepared at Froissy, Cerisy, and Mericourt, each of which would be held by a brigade. The C.R.E. was instructed to arrange for the necessary work at each bridgehead, in co-operation with the Brigadier concerned, and to prepare the bridges at those places for demolition. For this purpose 155th Field Co. was told off for Froissy—156th for Cerisy—and 157th for Mericourt.

Lieut. Webster was sent off with two lorries to fetch picks and shovels from the Army Dump at Chaulnes; he got there at 8 p.m. to find the place in flames. He then went on to La Flaque which was deserted and picked up the necessary tools. These he delivered at each of the bridgeheads, and reached H.Q., R.E., at 7 a.m. on the 25th, having covered a distance of nearly 70 miles in the dark over absolutely strange roads, and been within an ace of being captured near Chaulnes.

Divisional Headquarters moved that evening to Morlancourt. The C.R.E. arranged work and demolition at the three bridgeheads, and reached D.H.Q. *viâ* Bray at midnight. The latter town was seriously blocked with transport, and was bombed by the enemy though luckily no hit was obtained in the main traffic thoroughfare.

25th March.—The Division was transferred from the VII. to the XIX. Corps H.Q. Harbonnieres. D.H.Q. moved to Warfusee-Lamotte about three miles from Villers-Bretonneux.

The Field Cos. worked all day in preparing bridges at Froissy, Mericourt, and Cerisy for demolition, and in fortifying bridgeheads at these places. Ten bridges in all were got ready, including the railway bridge at Froissy, which carried a line of rail and double width railway on a 4ft. brick-arch span. Capt. Jennings, acting adjutant, scoured the country for gun-cotton and fuse, and sufficient was obtained to supplement that carried to make up the necessary charges.

The enemy was now developing a strong attack on the North of the Somme on the line Curlu-Montauban-Longueval.

The Brigades were moved up to a preparatory position west of

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Proyart with a view to holding up an advance on the south of the river. The Field Cos. were instructed to move into the village of Proyart, leaving a small detail at each group of bridges to carry out the demolition when ordered.

At 8 p.m. that evening information was received that the Fifth Army was falling back on the line Chaulhes-Bray-Albert, and the 16th Division was ordered to prepare and occupy the section of this general line between Proyart and the River Somme at Froissy, connecting on the right with the 39th Division.

The C.R.E. visited Brigade H.Q. at Moncourt and Mericourt, and the Field Cos. at Proyart, and made arrangements to start work at daybreak next morning.

26th March.—Soon after daylight the C.R.E. met the three Brigadiers at Proyart, and arranged the siting of the line, and details of work to be done. The defences of Proyart and line joining up with the 39th Division was given to the 11th Hants Pioneers—the remainder, a distance of about 6,000 yards, was sub-divided among the three Field Cos., each working on a Brigade Sector, with infantry parties provided by the Brigade.

A supply of wire was found at La Flaque and Froissy Dumps and there were plenty of picks and shovels at the former.

The line selected had a good field of fire into, and across, the small valley running from Proyart *viâ* Chignolles to the Somme at Froissy and was not under observation from the high ground further east, except on the left where it was overlooked from the north bank of the river. The line passed just in rear of Chignolles, which was at the bottom of the valley, and it was intended to deny the occupation of this to the enemy by rifle and Stokes mortar fire.

At about 1 p.m. Germans appeared on the south of the Somme, pushing in the advanced line of infantry scouts. Our half-completed line was soon under erratic but fairly brisk machine and field-gun fire. The R.E. and Pioneers, with the infantry working parties, stood to arms and lined the trenches and banks. The attack was not driven home, and at 3 p.m. the R.E. were relieved, and went back into support in Morcourt wood just west of Proyart.

In the meantime the ten bridges had been blown up by the R.E. detachments—a good job was made of the big Froissy bridge in which the crown was attacked, making a wide gap up to the abutment on each side.

At 4 p.m. the C.R.E. was ordered to reconnoitre a position covering Morcourt, to be garrisoned by the Field Cos. in the event of the Proyart line being forced back, and to dispose of the three Field Cos. for its defence.

The Field Cos. were accordingly moved back to a preparatory position close to Morcourt village. They had, however, very little rest that night, for at 2 p.m. on the 27th they were called upon to

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extend the left flank of the Divisional front, and guard the crossings of the Somme on the flank of the 49th Brigade. They marched off under the command of Major P. F. Whittall towards Froissy, and, based in the Froissy-Mericourt Road, pushed out an outpost line on the river bank from Froissy to Etinehem and Cerisy.

27th March.—The enemy attacked the Proyart Line at 9 a.m., and, after severe fighting captured the village of Proyart, forcing the 47th Brigade south-west, thus leaving the 48th and 49th Brigades in a precarious position. The 11th Hants Pioneers formed a defensive flank on the right of the 48th Brigade, and, being well handled by Lieut.-Colonel Crockett, facilitated the withdrawal of the 48th Brigade to the Morcourt Line. The 49th Brigade held on to the left flank, and commenced to withdraw at about 2 p.m. It was then reported that the Germans had crossed the Somme at Chipilly about one and half-miles in rear of the Morcourt Line.

The three Field Cos., who were on the extreme left guarding the crossings of the Somme, retired slowly, and protected the left flank of the 49th Brigade in their withdrawal. The Morcourt Line was, by this time, turned by the enemy crossing at Chipilly south-west on Lamotte. The position was extremely critical, as a rapid advance by the enemy on the Cerisy-Lamotte Road would have endangered the retreat of the 48th and 49th Brigades on Lamotte.

The R.E. and Pioneers did useful work at this juncture, for, advancing towards Cerisy, they opened heavy rifle fire on the advancing infantry, and gained valuable time for our Brigades. The 155th Field Co., under Major Scott, especially distinguished itself. The Co. was led forward to gain touch with the advancing infantry, and Lieut. A. G. Atock bravely charged and destroyed a machine-gun detachment.

This counter-attack had, undoubtedly, great effect on the hostile troops who had forced the Chipilly crossing, and took the pressure temporarily off the flanks of our retreating Brigades who successfully passed through Lamotte to the Marcelcave-Hamel Line.

In their left flank action the Pioneers fought splendidly, and Major Hazard, who did so well at Doingt on the 23rd, and Capts. Thyne and Maconochie, were all missing.

155th Field Co. were the last British troops to pass through the village of Lamotte, and they fought wonderfully for men who had had so little infantry training. Each section supported the other in its retirement, and the value of the left side of the street was fully realized and made use of. Lieuts. J. P. Haugh and C. V. Brook, and C.S.M. W. Argyle especially distinguished themselves.

For their brave and excellent work on this afternoon, Major Scott and Lieut. Atock were awarded the M.C.

At nightfall the 48th and 49th Brigades were holding the old French line running in rear of Lamotte village—as far as the village

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of Hamel—the Field Cos. and Pioneers holding the extreme right on the main Peronne-Amiens high road.

Divisional Headquarters remained at Hamel throughout this critical day. Meanwhile the Employment Co. and all batmen and spare clerks were organized for its immediate defence by the A.Q.M.G., Lieut.-Colonel G. A. C. Webb. The village was heavily shelled, but not attacked, and towards the evening Headquarters was moved to the Convent at Fouilloy, just clear of the town of Corbie.

28th March.—Advanced Divisional Headquarters was formed on the west edge of the Bois de Varie. The Division was relieved in the Marcelcave-Hamel Line by a mixed force of Tunnellers, A.T. Cos., Instruction Staffs, etc., raised and organized by Major-General P. G. Grant, Chief Engineer, Fifth Army. This Unit afterwards came under the command of Major-General Carey, R.A., and became known as Carey's force.

156th Field Co., R.E., had suffered heavily during the retreat, and its O.C., Major Holbrow was only able to muster twenty sappers. The Company was reinforced by the addition of some twenty infantry and a few sappers (the original Dump Party) from H.Q., R.E., under 2nd Lieut. S. A. Hall.

All three Field Companies were placed in close support at Hamel, and dug themselves into the side of a hollow road at the Southern exit of the village. The men looked, and were very tired, but their spirits and moral remained unimpaired. Major Whittall, who was a splendid example of cheerfulness to everyone, told me that afternoon that the men were fit and willing for any job of work or fighting, but it was useless to expect any rapid movement out of them.

I found Major Holbrow in a cottage at the edge of the village, helping his company cook to make stew. His first thought, at all times, was the care and comfort of his men, and it was only a little later in the same afternoon that, in leaving his billet during a bombardment to look after three of his men, he was killed by a shell, and so passed away a fine young officer " sans peur et sans reproche." Capt. Jennings, who accompanied the C.R.E. that afternoon, was wounded in the leg by a shell splinter, but remained at duty.

The 48th and 49th Brigades, together with the R.E. and Pioneers, were now formed into a mixed Brigade under Brig.-General F. W. Ramsay.

Total Strength	700 rifles.
Infantry—as 2 battalions ...	... 380
Pioneers—as 1 battalion ...	... 200
R.E.—as 1 battalion	... 120
	700

Capt. Tilly was in command of the Pioneer Battalion, and Major Whittall of the R.E. Battalion.

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29th March.—The fine spell of weather now broke, and during the night there was a very heavy fall of rain which continued off and on all day.

The British line covering Corbie and Villers-Bretonneux was strengthened by the arrival of the 1st Cavalry Division at Fouilly, and two Australian Divisions on the west bank of the Somme.

The C.R.E. went up to Hamel and selected sites for an advanced dump at north-west edge of Hamelet. Meanwhile Lieut. Webster went off to XIX. Corps Headquarters and obtained a supply of wire and pickets and some tools, which were taken forward by him after dark to the Hamel Dump.

30th March.—The weather cleared somewhat, and there was much enemy aerial activity. Two big flights of Fokkers were operating for an hour over our lines, until engaged in a heavy air battle by our scouts, and chased away. A very heavy barrage was put down at 11 a.m. by the enemy on the front line (held by Carey's force) and Hamel, followed up by an infantry attack. The enemy succeeded in entering the front line just east of Hamel, and the R.E. and Pioneers were called upon by the Brigadier, 48th Brigade, to counter-attack. The R.E. counter-attack was delivered in three lines—157th leading under Lieuts. J. R. Osmond and E. H. Barcroft, supported by the 156th in two lines, led by Capt. J. Shelly, with Lieuts. S. A. Hall and E. H. Norman. It was a gallant little effort and was completely successful in driving the enemy out of the part of the front line and support lines occupied. Various infantry officers told me that it was an inspiring sight to see those three thin lines going ahead at a steady double over the open. Three out of the four officers became casualties—Lieuts. Hall and Norman being killed, and Lieut. Osmond wounded. Also Sergt. Hughes and 2nd Corpl. Fryer, D.C.M., M.M., a brilliant young N.C.O., were killed.

The Sappers remained in the line until relieved next morning, and excellent work was done by Lieut. Atock, 155th Company, R.E., who worked backwards and forwards with a small party of Sappers, carrying up rations, water, and ammunition. One of the party, Sapper Finlayson, afterwards received the D.C.M.

During the night a squad of infantry were taken up by Lieut. Webster, and some useful wiring done.

31st March.—A day of brilliant sunshine. Orders were issued that Carey's force was to be relieved by the 1st Cavalry Division, and that the 16th Division would take over the portion of the line between Hamel and the Somme. The C.R.E. reconnoitred the front line with Lieut. Webster, with a view to improving the defences in the 16th Divisional Sector. The German dead were lying about in heaps, showing how heavily the 228th Bavarian Division had suffered in their attempt to wrest Hamel from our possession on the previous day.

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The line held by our troops was an old French defence trench, much fallen in and shallow, but with very fair wire in front. With a little work it seemed easily capable of strengthening and improvement.

The opportunity was taken by the C.R.E. of inspecting the bridge across the Somme at Bouzencourt. This was partially blown but quite passable for infantry. It had been apparently struck by a shell which caused one charge to detonate, cutting the girder on one side only. As the bridge was just in rear of our front line it was a bit of luck that the demolition had not been more complete. Capt. Hughes, 155th Field Co., took a limber with explosives up to Bouzencourt after dark, and prepared this bridge for demolition in case of further retirement.

During the night 31st March—1st April, the Field Cos. were withdrawn from the line to Aubigny and the Hants Pioneers to Vaire.

1st April.—Work was organized for improving our front line, and for preparing a switch line from the village of Vaire to meet the mail road near Villers-Bretonneux. The latter was sited in conjunction with the 1st Cavalry Division, and work was started by our R.E. the same evening.

The 11th Hants, under Capt. Howson, commenced deepening and revetting the shallow parts of the front line, and in strengthening the wire.

2nd April.—Very heavy German bombardment to the south of Villers-Bretonneux, but quiet on our front. The weather was fine, and some useful work was done on our defensive system and the switch line.

3rd April.—16th Division was relieved by the 14th Division, and the Field Cos. were moved by 'bus to Salleux late that afternoon.

This brings to a conclusion these few notes on the work and fighting of the Royal Engineers 16th Division during the critical period, 21st March to 4th April.

It is an interesting fact that each Field Co. learnt the use of Lewis machine guns on the retreat, and, finally, between 30 and 40 of these weapons were handed over to the infantry, after having done excellent service.

In the form of an appendix are added a Special Order of the Day, issued by General Sir H. P. Gough, commanding the Fifth Army, and three letters received from the Divisional Commander and Brigadiers of the 16th Division, in kind appreciation of the efforts of the R.E.

I think it can be fairly said that the Sappers, under difficult and unusual conditions, did their best to worthily uphold the traditions of the Corps, and that they have, perchance, also earned the right to say with their brothers of the infantry

"Et militavi non sine gloria."

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APPENDIX.

SPECIAL ORDER OF THE DAY.

By GENERAL SIR H. DE LA P. GOUGH, K.C.B., K.C.V.O., Commanding Fifth Army, dated 26th March, 1918.

I wish to express to all Officers and men of the Fifth Army my immense admiration for the truly magnificent way all ranks have fought in this desperate struggle against immense odds. The very grandest traditions of British soldiers and of the British race have been maintained. We are fighting for our lives, our existence, our honour, and in your hands all these are safe. It is a matter now only for few days before reinforcements arrive to alter the situation.

(Sd.) H. P. GOUGH, *General.*

2nd September, 1918.

MY DEAR BUTTERWORTH,

Your letter reached me just as we were starting the fighting in these parts, hence the delay in answering.

I am very glad to hear that the deeds of the Field Cos. of the 16th Division during last March and April are to be brought to light. Their fighting qualities were beyond praise, and they helped the remains of the infantry in many a tight corner by their dash and grasp of the situation.

Notably the 156th Co., on March 21st, at St. Emilie, where the fighting was hard and the situation at the moment decidedly mixed. On March 23rd the 157th Co. attached to the 49th Infantry Brigade put up a stout resistance on the extreme right of our line, and when the order to withdraw was sent, gave material assistance to the Brigade when passing through Doingt.

I think one of their best actions was when the three companies were ordered to move from Morcourt to Mericourt during the night of 26th-27th March, in order to guard the crossings at the latter place, and probably the left of the 49th Infantry Brigade. Owing to the enemy pressure forward on the north of the river, and eventually crossing at Chipilly on the 27th, our left was under heavy fire from its flank and rear, the way the Engineers held their ground and eventually fought their way back was splendid.

The 155th Co. I remember especially did good work there. I have no doubt there are other instances, but these showed what stuff they were made of, and how they proved themselves first-class fighters

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in a first-class fighting division. You, yourself, deserve every credit for this, and I am glad to have the opportunity of again thanking you for all you did during those strenuous times.

Yours very sincerely,

AMYATT HULL,

G.O.C. 16th (Irish) Division.

1st September, 1918.

MY DEAR BUTTERWORTH,

I am very glad to hear that you are putting on record the extraordinarily fine work performed by the R.E. Cos. of the 16th Division during the operations of the 21st March to 3rd April.

It was towards the evening of the 21st, and during the following days when the whole of the infantry of the Division were engaged, and losses had been very heavy, that the fighting and steadiness of the R.E. Cos. were of invaluable assistance. Especially noticeable was the gallantry displayed by the 156th Co. at St. Emilie on the 21st, by the 157th Co. at Doingt on the 23rd, and by the 155th Co. who covered the retirement on the 27th. On the morning of the 30th, when the Divisional Front was attacked and partially penetrated, the bravery of all three companies in the counter-attack was worthy of the highest traditions of the Army.

The R.E. Cos. of the 16th Division have at all times been held in high esteem by the Infantry for their personal fearlessness and the high standard of their technical work in the line, but during these operations they demonstrated that, in addition their *morale* and fighting qualities as a formed body, acting as Infantry, left nothing to be desired.

Yours ever,

P. LEVESON-GOWER.

Commanding 49th Infantry Brigade,

HEADQUARTERS,

58TH DIVISION,

6th April, 1918.

DEAR BUTTERWORTH,

I am anxious that my appreciation of the good work of the R.E. Cos. during the operations 21st March to April 3rd, when attached to my Brigade, should be conveyed to all ranks.

I may especially mention the fighting work of the 156th Co. on the right flank at St. Emilie on the 21st March, of the 157th Co. in passing through Doingt on the 23rd, and in the withdrawal from

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Morcourt on 27th, on which day the 155th also did good work in holding up the enemy's advance at Warfusee-Lamotte; and of all these companies in the counter-attack against the Bavarians on the morning of the 30th March.

They worked well and in good formation under shell-fire, and though not trained as infantry, they were equal to the best, and showed great determination and pluck throughout the operations.

Yours sincerely,

FRANK RAMSAY,

Commanding 48th Infantry Brigade.

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A FIELD COMPANY ON PACK TRANSPORT.

METHODS EMPLOYED BY THE 2ND WESSEX FIELD CO., R.E. (T.F.).

Described by CAPTAIN G. C. SANFORD, R.E.

IN certain of the Expeditionary Forces where most of the roads to be negotiated are unsuitable for wheeled transport, it has been found advisable to adopt Pack Transport for all 1st Line Units including, of course, the Divisional R.E. Field Companies. It is obviously impossible to carry pontoons on pack mules, and it was found advisable to slightly reduce the tools, etc., normally carried by the H.Q. and sections with their wheeled transport. A Divisional R.E. train was therefore formed consisting of the pontoons and trestle wagons of all three Field Companies, and each company supplied two limbers to this train. The tool carts, forage carts, water cart, cook's cart, and H.Q. vehicles were withdrawn from the companies and pack mules and saddlery were issued in lieu. Appendix 1 gives the mounted establishment of a Field Company on Pack Establishment as adopted by the Salonica Army, and Appendix 2 gives a detailed list of the pack saddlery. While the companies were in the line they temporally retained their pontoon and trestle wagons, and the two limbers belonging to the Divisional R.E. train; 16 drivers and 32 mules belonging to Divisional R.E. H.Q. being temporally attached to each company. Appendix 3 gives general description of the loads carried by each of the H.Q. mules, and Appendix 4 shows the general loading of the section pack mules. The total weight of the pack saddlery is about 70 lbs., including feeds and saddle cover. The average load including pannier or other carrying contrivance is 90 lbs. a side, and the driver's kit will scale, say 20 lbs., so that the total load carried by the mule is about 270 lbs. One of the common causes of trouble with pack work are the loading ropes. These ropes are made up in pairs with loops to hook out the pack saddle hooks and leather distance pieces about 12 in. long between the two ropes. When skilfully handled loading ropes can be made to sling all sorts of seemingly unweildy loads, but wherever a load is of a uniform pattern, it is better to arrange for permanent rings on the load or carrier so that the loads cannot slip in the ropes, and the risk of a badly-roped load getting loose or shifting is obviated. Referring to Appendices 3 and 4, it will be noticed that only 12 out of the 32 loads in the H.Q. list are loaded with pack ropes, and only 12 out of the 34 in the section lists. To

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illustrate the method of making up the loads, we will go through those shown on Appendices 3 and 4. The first load in Appendix 3 (Company H.Q. loads) is the anvil, this is carried as a top load, the wooden anvil block being sawn vertically in half and each half fitted with an iron bar and two rings in such a manner that when the two half blocks are slung on the saddle they form supports for the anvil; the latter being lifted out and across them, and then lashed to the saddle. A field company anvil should weigh 140 lbs., but if a rather lighter one can be obtained for pack purposes it is an advantage, as it is an awkward load, and in lifting it on and off an accident can easily occur. No. 2 load forge and bag of coal on the near side are carried by fitting two carrying rings to the forge body and lashing the bag of coal inside it. The grindstone case on the off-side, with the forge legs lashed to it, being also fitted with carrying rings. It is important when fitting up pack loads to keep the weights well up on the pack saddle, and of course great care must be exercised to ensure that the loads do not project so as to gall the shoulder or flanks of the mules when turning. No. 3 load Clarkson chests containing small tools and instruments are already fitted with loading rings when issued; the same applies to the entrenching bags used for Nos. 4 and 5 loads. No. 6 load shoemaker's valise on the near side is secured by loading ropes; the leg vice and bag of coal on the off side are lashed together and carried by loading ropes. No. 7.—These loads, the veterinary chest and plane table on the near, and the stretcher and veterinary wallet on the off, are also lashed and carried by loading ropes, the stretcher being slung at an angle of about 30 degrees, so as to clear the shoulder and flank of the pack mule. The pieces of round bar iron and flat iron and steel carried as No. 8 load are best cut into lengths of about 3 ft. 6 in., and made up into bundles, the end of the bundles being fitted into two light metal or leather buckets, with a strap connecting them together. The bundles can then be carried horizontally, though possibly with a slight lift in front, by loading ropes or by short chains secured to the buckets. No. 9 load stationary boxes can be carried by loading ropes or short chains can be rivetted to the boxes. It will be noticed that Nos. 10, 11, 12 and 13 mules carry respectively entrenching bags and panniers, but these are empty, so that practically speaking, the mules are spare. The panniers are strong wicker baskets fitted with short loading chains and rings, the lids are covered, and the insides of the baskets lined with oil cloth to keep out rain. These pannier baskets are very much like a small theatrical hamper, and being light but strongly made, are very useful for carrying small tools. No. 14 load is a pair of panniers with officer's mess gear. No. 15, the major's and captain's valises carried with loading ropes. No. 16 is a packhal (*i.e.*, a galvanised iron water tank 2 ft. × 1 ft. × 8 in. in size, and of a capacity of approximately

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8½ gallons). It is carried by loading ropes on the near side, the cook's dixies packed in a sack and carried by loading ropes being carried on the off side. Referring to Appendix 4 (Section Loads), Nos. 1 and 2 loads are picks and shovels carried in wooden frames called "Kajawahs," *Fig.* 1. Each kajawah is constructed to

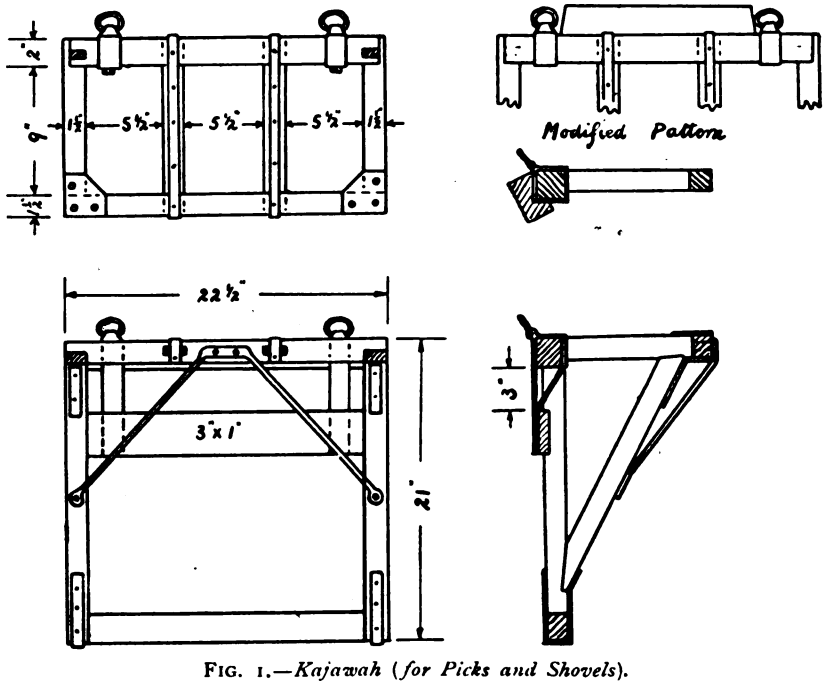

FIG. 1.—*Kajawah (for Picks and Shovels).*

carry 13 or 14 picks and shovels; it is a wooden frame-work about 22 in. square, against the pack saddle pad, with a 22 in. × 12 in. carrying frame divided into three compartments standing out at right angles to the saddle pad frame, and braced off it with angle struts. The kajawah is fitted with loading rings, and is metal bound at the corners, the weight being about 16 lbs. The tools are carried in the frame heads upwards, the helves and handles being snake-lashed to the lower part of the frame, so that the complete load can be lifted off without any trouble. A short surcingle connecting the near and off kajawahs is an advisable adjunct. No. 3 load consists of sandbags made up into bales and carried with loading ropes. Nos. 4, 5, and 6 are various tools carried in entrenching bags, *i.e.*, leather bags about 2 ft. × 1 ft. × 8 ins., fitted with heavy straps and loading rings. No. 7 load, carpenter's leather hold-all on the near and smith's ditto on the off side, are carried with loading ropes. The section's measuring rods reduced from 6 ft. to 5 ft. are carried on the outside of the near load. No. 8 load comprises the section grindstone fitted with loading rings (as in No. 2 H.Q. load), with

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picket line and farrier's bag lashed to it, and various heavy ropes and lashings coiled and carried with loading ropes forming the off load. No. 9 load consists of a coil of 2½ in. rope and a small quantity of plain wire on the near, and a pair of 2½ in. blocks lashed into a coil of 1½ in. rope on the off side, both loads being secured with loading ropes. No. 10 load, panniers containing demolition gear. No. 11, tins of amonal carried in a pair of boxes, Noble pattern,* (*Fig.* 2). These boxes are made of light gauge iron, and are

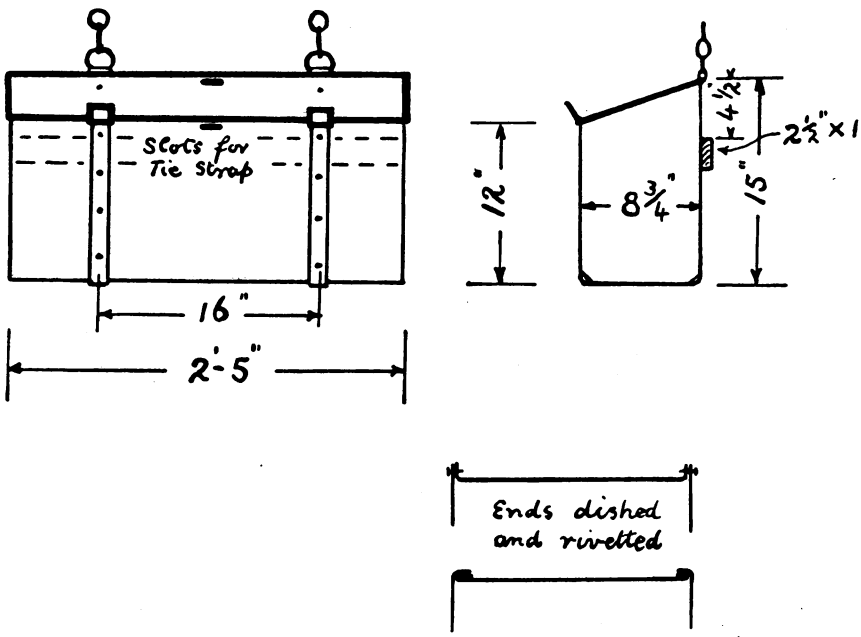

FIG. 2.—*Box "Noble" Pattern.*

almost identical in shape with the entrenching leather bag; they are fitted with short chains and loading rings, over all dimensions being 2 ft. 5 in.×12 in.×8¾ in. They are specially designed to take eight tins of amonal and a tin of detonators and safety fuze each. No. 12 load, panniers containing gun cotton and primers. No. 13 load, two boxes of S.A.A.; these boxes are rather small for securing with loading ropes, the total length of the box being only 16 in., while the pitch of the pack saddle loading hooks is 15½ in.; it is therefore advisable to fit the ends of the S.A.A. boxes with a pair of light iron strips about ¾ in.×¼ in., carried down the back along the bottom, and an inch or two up the front of the box, and secured to it with a few short wood screws, the top of the strips being fitted with loading rings. No. 14 load, pump on near and hose for same on off side. The pump of the ordinary service pattern

* Invented by Major N. D. Noble, D.S.O., R.E.

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having a new base fitted to it. This base is formed by two 4 in. × 2½ in. timbers, 2 ft. 8 in. long, bolted to the pump lugs, through the 2½ in. section, the two timbers being spaced out with 2 in. blocks, just under the ends of the pump cylinder. Long bolts with loading rings in the heads are carried through both longitudinal timbers and distance pieces, the rings being on the delivery side of the pump (*Fig.* 3). The strainer is carried screwed on to the suction

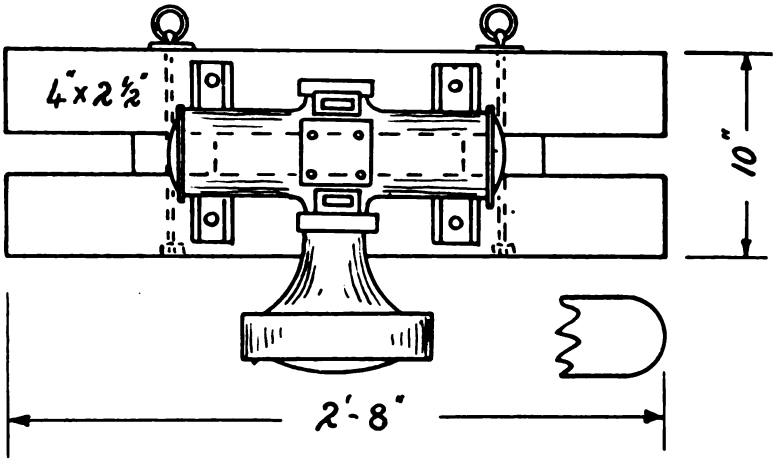

FIG. 3.—*L. and F. Pump (Off Load).*

orifice of the pump. The off-load (*Fig.* 4) is made by forming a

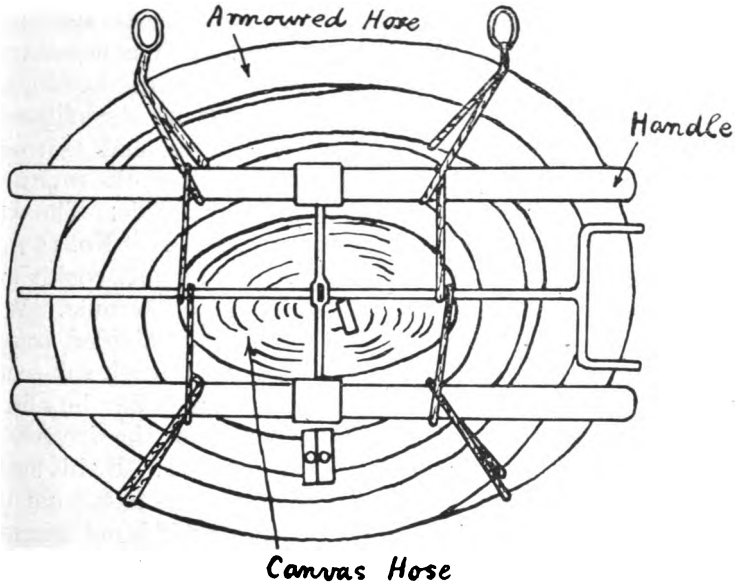

FIG. 4.—*Hose and Handle (Near Load).*

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continuous coil of two lengths of suction hose with one length of delivery hose rolled in the centre, the handle and lever of the pump being lashed to these coils and the whole load secured with loading ropes, the pump handles being slung against the pack saddle pad. No. 15 load packhals is carried as described in No. 16 H.Q. load. No. 16 load section officer's valise on near and cook's dixies on off are carried with loading ropes. No. 17 load two empty kajawahs these kajawahs being spares may be rather a modification of the pattern described for Nos. 1 and 2 loads, the top frame only with a shaped block at the back and loading rings being sufficient (*Fig.* 1), but of course this type of kajawah cannot be lifted on and off complete with load as in the more elaborate type. Appendix 5 gives complete table for all H.Q. and sectional pack loads and list of stores carried by Divisional H.Q. wheeled transport for each field Company. On perusal of these tables it will be noticed that the various loads are as far as possible arranged so that certain mules can be sent off with the tools or gear required for certain jobs. This feature of the pack transport has been very carefully considered, especially in the case of the sectional equipment. For instance, if the section is suddenly called upon for any digging or entrenching work, Nos. 1, 2, and 3 mules are loaded with the necessary tools and sand bags. If the section is required to do any temporary wiring, which in a rough country would probably necessitate felling and sharpening the pickets on or near the site, then Nos. 4 and 5 mules will be found to be carrying all the necessary tools. No. 6 mule carrying principally supplementary tools of the same class as Nos. 4 and 5. If any carpenter's or joiner's work is required, then the near load of No. 7 mule will be required, and smith's iron and tin and mason's tools will be found in No. 7 off load. If it is necessary to carry out any work necessitating the use of ropes and tackle, then Nos. 8 and 9 mules will be wanted. Materials for demolitions or blasting will be found loaded on Nos. 10, 11, 12, and 13 mules; and if water has to be pumped from a well or river, the pump and hose pipes, etc., will be found complete on No. 14 mule. The water supply for the section while on the march is carried by No. 15 mule, and everything necessary for a temporary camp, *i.e.*, cook's gear, a shovel, pick and axe, etc., will be found on No. 16 mule. When on the march, each section of sappers should be sub-divided, roughly according to trades, the N.C.O. or senior sapper of each sub-section being made responsible for the loads of certain mules, he and his men loading and unloading their allotted mules for the drivers, and re-roping their loads if any of them slip or get loose. If this system is adopted it becomes automatic for certain sappers to fall out with any driver who is in difficulties with his load, and it is not necessary for the section officer or serjeant to select and fall out men specially for the job. The mounted N.C.O. simply informing the sapper

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N.C.O. in charge of, let us say, No. 7 mule's load, that this load requires attention. The N.C.O. in charge of each sub-section should carry a detailed list of the tools in each of the loads under his charge, and the officer and serjeant complete lists of the distribution of all tools. Roughly the sub-sections should be made up as follows :—

(*a*).	Digging Party	1 N.C.O. and 6 men.
	Trades	5 bricklayers, 1 surveyor and 1 blacksmith.
	Mules	Nos. 1, 2, and 3.
(*b*).	Cutting Party	1 N.C.O. and 6 men.
	Trades	6 carpenters and sawyers, and 1 wheelwright.
	Mules	Nos. 4, 5, and 6.
(*c*).	Carpenters' Party	1 N.C.O. and 6 men.
	Trades	4 carpenters, 1 blacksmith, 1 tinsmith, 1 mason.
	Mules	Nos. 7, 8, and 9.
(*d*).	Demolition Party	1 N.C.O. and 6 men.
	Trades	2 masons, 2 painters, 1 engine driver, 1 pioneer, 1 cooper.
	Mules	Nos. 10, 11, 12, and 13.
(*e*).	Water and Cooks' Party	1 N.C.O. and 6 men.
	Trades	2 fitters, 2 plumbers, 1 plasterer, 1 tailor, 1 clerk.
	Mules	Nos. 14, 15, and 16.

NOTE.—Section officer and serjeant are responsible for general supervision. The detailed trades are, of course, only given as a guide to the general idea of the scheme. In loading and unloading a pack mule it is generally necessary to have two men for each load. The driver should stand facing, but not looking into the eyes of his mule, with the reins held in both hands. If his mule is nervous he will, of course, endeavour to soothe the animal. The four sappers detailed to load the mule must lift both loads together, slipping the loading rings on to the fore hooks of the pack saddle first, and then on to the hind hooks. It is important to load in this manner, as the weight coming on the shoulders of the mule first is less likely to upset the animal if it is at all nervous than if the weight is first felt on the hind quarters. The sappers should try to support the loads until both are properly hooked on and then release them gently. Having fixed the loads the driver's kit must be placed in position between them, and the pack saddle cover slipped over the lot. The pack saddle cover is secured by a long surcingle. This surcingle should always be passed over the load from the near to the off side, the buckle being kept well up on the near side about level with the animal's shoulder blade. The pull when tightening the surcingle will thus be downwards, which is easier for getting it properly tightened up. The loose end of the surcingle must, of course, be tucked up out of the way. Drivers leading mules should march on the near side of their animals with their rifles slung from the

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left shoulder. When acting as pack mule men they should not, of course, parade in spurs. When leading a mule the driver must hold the reins with his right hand fairly near the bit, and his left hand at the end of the reins, but over very rough country, he should lead at the full length of the reins. When about to negotiate a stretch of stiff uphill track the breast collar straps should be slightly tightened. When negotiating a bad down grade track the breeching straps should be tightened. When pack mules are first saddled up in the morning, it is a good plan to lead them round for a few minutes before actually loading. After leading them round, the girths should again be tested, and probably most of them can be slightly tightened up. With the new pattern pack saddlery, the girths should be crossed, one girth passing from the near fore to the off hind, and being secured first, while the other passes over it from the off fore to the near hind. When a driver is leading two mules, the second one should be secured by its head chain to the near hind hook of the leading mule's pack saddle.

After a long march, the pack saddles should be left on the mules backs for half-an-hour or so, to allow the animals to cool off, the girths, of course, being eased. After they are taken off, the pack saddles should be placed in such a way that as much air and sun as possible is able to get on the inside of the saddle pads. After a long march with heavy loads, a pack mule will often be found to have developed a swelling, varying in size from an egg to a man's fist under the belly. This is nothing serious, and is simply caused from unavoidably tight girths. The swelling will usually have gone down by the morning. Galling under the tail from the crupper is a common trouble with pack mules. If a mule shows a tendency to develope such galls, the crupper can be removed, as it is really of very little use. On the march, and in fact at all times, pack mules should be watered as often as possible. It will not hurt them to take a little water with their loads on, but wherever possible the packs should be off-loaded, and the girths eased and bits removed. When a section is halted and the mules are to be off loaded they should be lined up about five yards in front of the place to be occupied by their loads, so that the four men unloading can lift the packs off and carry them back to the place allotted. If the weather is cold, spare blankets for the men of the section can be carried folded square between the mules' blanket and the pack saddle. If this is done, however, care must be exercized to so arrange the blankets that there is an air space along the back bone of the animal. It is sometimes not practicable to head and heel picket the mules, because many mules are liable to gall from the heel straps. A good method of fixing up a temporary mule line is to head picket all the animals in a line with head chains and iron pickets, and then pass a light 66 ft. picketing rope through the rings of all the iron pickets, securing

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it with a wooden picket at each end. By this means if one mule should pull its head picket out it is still held by the picket rope to the head pickets of the animals on either side of it. If the country allows, the pack mules should march parallel to the sappers, otherwise the column becomes very long and unwieldy. In passing through enemy country it may sometimes be necessary to divide the pack transport of a field company into 1st and 2nd line, the 1st line marching with the sections, and the 2nd line being attached to the 2nd line transport of the main body of troops on the march. In this case all the H.Q. pack mules would probably become 2nd line transport, and the sections' transport would be divided up according to local requirements. Probably mules Nos. 1, 2, 4, 10, 11, and 15 and the spare animal No. 17 of each section would be 1st line, and the other animals of the sections would become 2nd line, but, of course, the actual arrangement on any particular days march would depend entirely on local conditions, and any special work which it was anticipated that the company might have to negotiate. It is very important before taking pack mules on a long march that each animal should be individually fitted with a full set of spare shoes, these being carried in the shoe case with a sufficiency of nails. In soft country, it is not an uncommon practice to only shoe mules on the fore hoofs.

Transporting R.E. Stores on Pack Mules.

When wiring materials have to be transported by pack mules, the following loads can be carried :—

(*a*). Four coils of barbed wire, two on each side, carried with loading ropes.

(*b*). Sixteen angle iron 6-ft. pickets, eight on each side; carried with loading ropes (the ropes should be longer from the hind than the fore, back saddle hooks to allow the load to ride free of the mules shoulders).

(*c*). Eight lengths of French concertina wire, four on each side; each length should be twisted into the form of a figure 8 lashed in this shape and carried with loading ropes so fixed that the figure 8 rides at an angle of about 30 degrees.

(*d*). Wooden pickets 6 ft. long (number according to weight) carried in the same way as iron pickets.

(*e*). Short 3 ft. pickets carried either in entrenching bags or in sacks lashed up and secured with loading ropes.

(*f*). Sand bags. A strong mule will carry two bales of 250 bags each for a medium distance. The bales are secured with loading ropes.

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For carrying small quantities of CG1 sheets, heavy timbers, etc., mule-drawn skids (see *Fig.* 5) are very useful, two or more mules

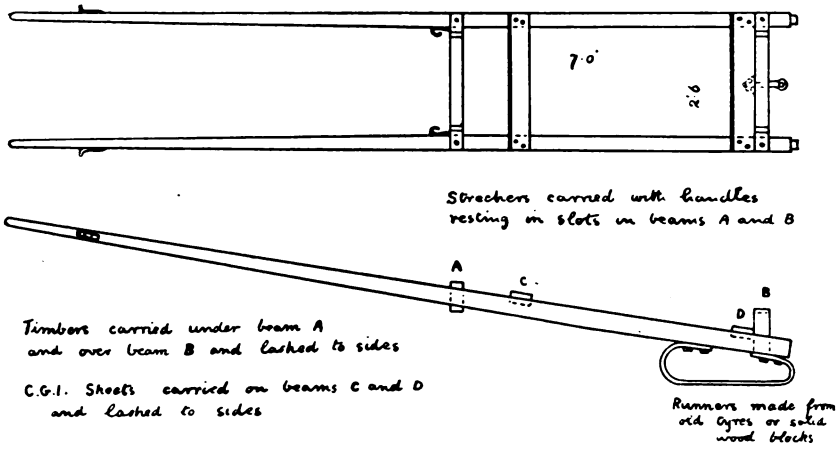
7·0
2·6
Stretchers carried with handles resting in slots in beams A and B
A
C
B
D
Timbers carried under beam A and over beam B and lashed to sides
C.G.I. Sheets carried on beams C and D and lashed to sides
Runners made from old tyres or solid wood blocks

FIG. 5.—*Skid for Hill Tracks.*

being harnessed tandem fashion to them. The skids should be equipped with a tail rope so that a man can guide them from the rear. These skids fitted with stretchers are very useful for transporting wounded. The shafts should be as springy as possible, and if thus constructed the jars to the stretcher case are surprisingly light. Palaquins with shafts at each end slung between mules are not very satisfactory, as they are too long and cumbersome, especially in negotiating corners.

APPENDIX I.

MOUNTED ESTABLISHMENT OF A FIELD COMPANY ON PACK.

Headquarters of Company.

2 Officers	4 Riding Horses.
1 C.Q.M.S.	1 ,, Horse.
2 Mounted Sergeants	2 ,, Horses.
1 Farrier-Sergeant	1 ,, Horse.
1 Farrier-Corporal	1 ,, ,,
1 Shoeing and Carriage Smith	1 ,, ,,
2 Lance-Corporals	2 ,, Horses.
1 Horseholder	1 ,, Horse.
1 Lance-Corporal (as Driver), 20 Drivers, 4 Batmen ...	16 Pack Mules.

EACH SECTION.

1 Officer	1 Riding Horse.
1 Corporal or 2nd Corporal	1 ,, ,,
1 Lance-Corporal (as Driver), 7 Drivers, 1 Batman ...	17 Pack Mules.

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TOTAL.—21 riding horses (1 extra horse is allowed if the Company has an interpreter attached), and 84 pack mules. Subsequently some of the mounted N.C.O.'s. were issued with riding mules in lieu of horses. Each driver is responsible for 2 mules, so that 13 of the Company H.Q. drivers can be called spare, and can be attached to the section as required. It will be noticed that the actual sectional establishment necessitated the officer's batman leading the spare mule. The extra establishment of drivers was allowed in the Salonica Army to cover sickness, malaria being very prevalent, and it was also realized that it was not always practicable for one man to lead two mules under certain conditions.

APPENDIX II.

PACK SADDLERY FOR MULES.

Pack Saddle.
Breechings, breast piece and girths.
Head stall, bridle and bit.
Head chain.
Wood picket and heel strap and rope.
Iron picket for head chain.
Horse blanket folded under saddle.
Shoe case (containing 4 shoes and nails).
Body brush (hung by wire loop from saddle).
Feed bag (10 lbs. of forage).
Feed bag (unexpended forage).
Drivers' kit (packed in ground sheet and carried lenghtwise on top of saddle),
Two loading ropes (hung from saddle if not required for load being carried).
Pack saddle cover and surcingle (carried over entire load).
Total weight including feeds, but not drivers' kit, about 70 lbs.
Canvas Water Buckets.—Company H.Q. pack mules 21 buckets, and 9 for pack mules of each section.

APPENDIX III.

PACK TRANSPORT, COMPANY HEADQUARTERS MULES.—TOTAL, 16 MULES.

(Loads marked * secured by loading ropes.)

Mule.	Near Load.	Off Load.
	Anvil	(Top load).
No. 1 ...	½ Block	½ Block.
No. 2 ...	Forge and coal.	Grindstone and forge legs.
No. 3 ...	Clarkson chest, carpenter's tools, etc.	Clarkson chest, instruments, etc.
No. 4 ...	Bag, intrenching, saddler's outfit	Bag, intrenching, soap, lanterns, etc.
No. 5 ...	Bag, intrenching, reaping, and bill hooks, etc.	Bag, intrenching, smith's tools, etc.
No. 6** ...	Shoe maker's valise.	Leg vice and coal.
No. 7** ...	Vet. chest and plane table.	Stretcher and vet. wallet.
No. 8** ...	Bar, iron	Flat iron
No. 9** ...	Box, stationery	Box, stationery, wire rope.
No. 10 ...	Bag, intrenching (empty).	Bag, intrenching (empty).
No. 11 ...	Pannier, " A " (empty).	Pannier, " A " (empty).
No. 12 ...	Pannier, " B " (empty).	Pannier, " B " (empty).
No. 13 ...	Pannier, " C " (empty).	Pannier, " C " (empty).
No. 14 ...	Pannier, mess gear.	Pannier, mess gear.
No. 15** ...	O.C.'s kit.	Capt's kit.
No. 16** ...	Packhal.	Cook's gear.

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APPENDIX IV.

PACK TRANSPORT, SECTION MULES.—TOTAL, 17 MULES.

(Loads marked * secured by loading ropes.)

Mule.	Near Load.	Off Load.
No. 1 ...	Kajawah picks and shovels.	Kajawah picks and shovels.
No. 2 ...	Kajawah picks and shovels.	Kajawah picks and shovels.
No. 3** ...	150 sandbags, etc.	150 sandbags, etc.
No. 4 ...	Bag, intrenching, axes, crowbar, etc.	Bag, intrenching, axes, wire cutters, etc.
No. 5 ...	Bag, intrenching, axes, heavy hammer, etc.	Bag, intrenching, axes, boring bar, etc.
No. 6 ...	Bag, intrenching, adzes, tracing tapes, etc.	Bag, intrenching, hooks, reaping, lamps, etc.
No. 7** ...	Holdall, R.E., carpenter's tools.	Holdall, R.E., smith's tools, etc.
No. 8* ...	Grindstone, picket line, and farrier's bag.	2-in. rope, and lashings, etc.
No. 9** ...	2½-in. rope and wire.	Blocks and 1½-in. rope, etc.
No. 10 ...	Pannier, "A" exploder and cable, etc.	Pannier, "A," guncotton and auger, etc.
No. 11 ...	Box, Noble pattern, ammonal, etc.	Box, Noble pattern, ammonal, etc.
No. 12 ...	Pannier, "B," guncotton primers, etc.	Pannier "B," guncotton.
No. 13 ...	S.A.A. box	S.A.A. box.
No. 14* ...	Pump.	Hose, etc.
No. 15** ...	Packhal.	Packhal.
No. 16** ...	Officer's kit.	Cook's gear.
No. 17 ...	Kajawah (empty) (small type).	Kajawah (empty) (small type).

APPENDIX V.

PACK TRANSPORT LOAD TABLES FOR A FIELD COMPANY, R.E.

HEADQUARTERS.

No. 1 MULE.

Near.	lbs.	Off.	lbs.
½ Anvil	70	½ Anvil	70
½ „ block	25	½ „ block	25
	95		95

Anvil resting on 2 pick heads passed through hooks of saddle arches and secured with loading ropes.
Block cut in half and hung by rings and wire from arch hooks.

No. 2 MULE.

Forge (Careless pattern) fitted with rings and 2 wood chocks to prevent rocking when hung from arch hooks	70	Forge legs	28
Coal (auxiliary sack)	20	Grindstone	62
	90		90

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No. 3 MULE.

Near.	lbs.	Off.	lbs.
Clarkson chest, containing carpenter's tools, viz. :—	24	Clarkson chest, containing instruments, viz. :—	24
2 Augers (⅜-in. and ¼-in.) and handles		1 Compass, magnetic plane table	
2 Chisels, brick, 18-in.		1 Box, instruments, drawing, filled...	
1 ,, coachmaker's		Pins, drawing	
1 Diamond, glazier's		Pens, mapping	
1 Gauge, carpenter's		1 Cloth, tracing, roll	
4 Gimlets (Nos. 1, 2, 3 and 6) ...		Paper, drawing	
3 Gouges (⅜-in., ½-in. and ¾-in.) ...		,, plane, table	
1 Knife, carpenter's		2 Protractors	
1 ,, putty		2 Rules, rolling, 15-in.	
1 Mallet, carpenter's		1 ,, sight, plane table, 16-in....	
4 ,, tinman's		1 Scales, Marquois, sets	66
1 Oilstone		1 ,, mathematical, boxwood, sets	
Oil, in bottle, for same		1 Set-squares, 6-in., 45°	
8 Doz. pencils, carpenter's ...		1 ,, ,, 60°	
6 Pincers, carpenter's (pairs) ...		1 Clinometers, pendant	
2 Glue pots (glue for same) ...	66	1 Level, pocket	
1 Rasp, half-round, 12-in. ...		1 Sextant, in case	
1 Rule, G.S., 4-fold		1 Plane table, legs	
1 Saw, compass		2 Screw-cutting sets	
1 ,, frame, 15-in.		8 Compasses, prismatic	
1 ,, tenon, 14-in.			
2 Screwdrivers (9-in. and 6-in.) ...			
1 Set saw, hand			
1 Spokeshave, carpenter's, 3¼-in. ...			
1 Square, carpenter's			
Screws, brass and iron, 3-lb. ...			
1 Plane, jack			
1 ,, plough			
1 ,, trying			
1 ,, smoothing			
1 ,, skew, rabbet			
	90		90

No. 4 MULE.

Near.	lbs.	Off.	lbs.
1 Bag, intrenching tool	18	1 Bag, intrenching tool	18
Saddler's outfit with holdall, 2 hides, 2 clams	59	1 Stone bottle acid, hydrochloric ...	
Dubbin in tin	1	12 Bars soap (yellow)	
Can oil, lubricating, armourers ...	3 oz.	4 Boxes candles, filled	
(This mule carries one water bucket)		12 Boxes matches, safety ...	
		2 Funnels, tin, ¼-pt.	
		2 Pairs handcuffs, common ...	60
		Balance, butchers	
		Flannelette, 88-yds.	
		72 Cartridges, Webley Pistol ...	
		2 Ropes, picketing	
		4 Lanterns, tent, folding	
	78		78

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No. 5 MULE.

Near.	lbs.	Off.	lbs.
1 Bag, intrenching tool	18	1 Bag, intrenching tool	18
4 Hooks, bill		1 Pair farrier's pincers, horn cutting	
1 Reaping hook		Smith's tools :—	
Zinc, 1-lb.		1 Apron, basil	
200-lb. spring balance	18	2 Cutter's anvil, flat, 2-in. ...	
Files, handles and holders ...	7	2 Fuller's small top	
Last, shoemaker's	11	2 ,, F.S. bottom ...	
1 Cutter, wire, small pair ...		1 Punch, centre	
1 Hammer, sledge	10	3 Punches, hot ($\frac{5}{8}$-in., $\frac{1}{2}$-in., and $\frac{3}{8}$-in.)	
1 ,, tinman's creasing, 12-oz.	1	1 Punch, cold	
Oil, lubricating, G.S. 7 pints ...	10	1 Smith's rule	39
(This mule carries one water bucket)		1 Saw, hack	
		6 Blades	
		1 Square	
		2 Spanners, adjustable, 11-in. and 15-in.	
		Chalk, 2-lbs.	
		Tongs :—	
		1 Forebit	
		1 Hollow bit	
		1 Plier	
		Oil, lubricating, G.S. 6-pints ...	8
		Hammers :—	
		1 Claw, 16-oz.	
		1 Rivetting, 24-oz.	11
		1 ,, 12-oz.	
		1 Smith's, hand	
		1 Setting	
	75		76

No. 6 MULE.

Bags, tool, shoemakers, filled ...	47	Vice, standing	36
Materials	43	Coal in sack	54
	90		90

No. 7 MULE.

Chest, veterinary, filled	82	Stretcher, with slings	32
Plane, table, top (on outside) ...	8	Wallet, veterinary	7
		Nails, 50-lbs.	50
	90		89

No. 8 MULE.

Bar, iron, round, $\frac{1}{4}$-in.	56	Flat iron, 1-in. by $\frac{1}{4}$-in.	14
,, $\frac{3}{8}$-in.	14	Steel, mild hoop, 2-in.	4
,, $\frac{1}{4}$-in.	6	,, 1$\frac{1}{4}$-in. No. 14 ...	4
,, flat, 1$\frac{1}{2}$-in. by $\frac{3}{8}$-in. ...	14	tool, 1$\frac{1}{2}$-in. by 1$\frac{1}{2}$-in. ...	28
(Cut to suitable lengths and packed up from saddle by rolled sandbags hung from arch hooks)		,, $\frac{3}{4}$-in. square	28
		2 Axes, felling (in sacking) ...	12
	90		90

No 9 MULE.

Box stationery, filled, maximum weight	70	2 Boxes guncotton	50
(Mule carries 1 water bucket) ...		Galvanized wire rope	21
	70		71

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No. 10 MULE.—Spare, carrying 2 bags, intrenching tool.

No. 11 MULE.—Ditto.

No. 12 MULE.—Ditto.

No. 13 MULE.—Ditto.

No. 14 MULE.—Mess Gear.

No. 15 MULE.—Officers' Kit.

No. 16 MULE.

Near.	lbs.	Off.	lbs
Water pack	80	Cookery gear, kettles, camp etc., 3	80
	80		80

Equipment of One Section Field Company, R.E.

No. 1 MULE.

Near.	lbs.	Off.	lbs.
1 Kajawah	16	1 Kajawah	16
6 Shovels, R.E.	31	6 Shovels, R.E.	31
1 Spade	6	1 Spade	6
6 Picks	43	6 Picks	43
	96		96

No. 2 MULE.

1 Kajawah	16	1 Kajawah	16
7 Shovels, R.E.	35	7 Shovels, R.E.	35
1 Spade	6	1 Spade	6
6 Picks	43	6 Picks	43
	100		100

No. 3 MULE.

150 Sandbags	63	150 Sandbags	63
3 Pick helves	9	2 Shovel helves ...	4
		1 Axle helve	1
		1 Pick helve	3
	72		71

No. 4 MULE.

1 Bag, intrenching tool ...	18	1 Bag, intrenching tool	18
3 Axes, felling	18	2 Axes, felling	12
2 ,, hammer headed ...	4	3 ,, hammer headed ...	6
2 ,, hand	4	2 ,, hand	4
1 Crowbar, 4-ft. 6-in.	20	4 Billhooks	8
1 Maul	13	1 Hammer, spalling	12
		1 Scoop and scraper	3
		1 Axe helve	1½
		1 Maul	2
		1 Wire cutters, large ... (prs.)	3
		5 Pliers, side-cutting small ,,	5
		2 Gloves, hedging ... ,,	1½
		1 Saw, hand	2
	77		78

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No. 5 MULE.

Near.	lbs.
1 Bag, intrenching tool ...	18
3 Axes, felling	18
2 ,, hammer headed ...	4
2 ,, hand	4
2 Billhooks	4
1 Hammer, miner's, boring ...	8
1 Maul.	13
1 ,, helve	2
1 Axe ,, ...	1½
	72½

Off.	lbs.
1 Bag, intrenching tool	18
2 Axes, felling	12
3 ,, hammer headed... ...	6
2 ,, hand	4
2 Billhooks	4
1 Bar, boring, 4-ft.	17
1 Wire cutters, large (prs.)	3
5 ,, small ,,	5
3 Gloves, hedging ,,	1½
1 Saw, hand	2
	72½

No. 6 MULE.

	lbs.	ozs.
1 Bag, intrenching tool ...	18	
2 Adzes and handles ...	9	
1 Bar, boring 2-ft. 6-in. ...	9	
1 Saw, hand	2	
1 Case, saw, hand	2	
3 Tapes, tracing	5	
1 Pick	7	
3 Flags, distinguishing ...	1	
3 ,, poles ...	9	
2 Flags and pole, signalling ...	1	8
Nails	10	
1 Hammer, mason's mash ...	4	8
Spare parts, pump ...	3	
	81	0

	lbs.	ozs.
1 Bag, intrenching tool ...	18	
1 Hook, reaping	3	
1 Bar, boring 2-ft. 6-in. ...	9	
Soap	8	
1 Box tape	2	
2 Boxes dubbin	2	8
1 Board, sketching } ...	2	
1 Protractor }		
1 Tube, paper drawing ...	1	
2 Lamps, folding	14	
2 Boxes, candles	2	
1 Doz. matches		8
6 Railway dogs	13	
2 Hammers, claw	3	
Spare parts, pump ...	3	
	81	0

No. 7 MULE.

	lbs	ozs.
1 Holdall, R.E.	7	
2 Hammers, claw	3	
2 ,, fitters	5	
1 Bradawl		4
1 Oilstone	2	
1 Doz. pencils		4
2 Pincers	2	
2 Rules, G.S.		4
2 Saws, hand 26-in. ...	4	
1 ,, ,, rip	2	4
2 ,, folding	3	8
2 Screw drivers, 9-in. ...	2	
1 Saw, set (hand)		4
1 Square		12
1 Adze and handle	4	8
4 Augers, 29-in.—1-in., ¾-in., ½-in. and ¼-in.	5	
4 Auger handles	2	
1 Steel bevel		8
1 Brace and bits (24) ...	5	
9 Firmer chisels, 2 1½-in., 2 1¼-in., 2 1-in., ½-in., ¼-in., ⅜-in.	6	
1 Socket chisel and handle ...	1	
2 Files, saw		8
4 Gimlets (spike, Nos. 1, 2 and 3)		8
1 Hammer handle		8
1 Spokeshave		8

	lbs.	ozs.
1 Holdall, R.E.	7	
2 Sawyer's wedges	6	
2 Chisels, brick	6	8
1 Smith's brace and 3 bits ...	3	8
2 Mason's trowels	1	8
2 ,, mash hammers ...	9	
1 ,, point	1	8
1 Compass, wing		8
2 Spanners, adjustable ...	7	8
1 Tinman's snips		12
1 ,, iron	2	8
Solder	2	
Resin		8
Sal ammoniac		4
Zinc		8
Hydrochloric acid		4
1 Smith's hard chisel ...	2	8
3 Cold chisels	3	
2 Rivetting hammers ...	4	
1 Wrench, 9--in.	1	4
1 Bar, boring 2-ft. 6-in. ...	9	
6 Railway dogs	13	
3 Files and handles	3	
1 Set coloured chalks ...		4
3 Bags, line, gear	2	
1 Wire breaker		4
Twine, whipping		12

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No. 7 MULE—*Cont.*

Near.	lbs.	ozs.	Off.	lbs.	ozs.
1 Level (spirit) rule		8	1 Clinometer		8
1 Draw knife	1		1 Level, F.S.	3	8
2 Paint brushes		8			
1 Plane, Screws, 3-lb. ...	9				
Nails, assorted	10				
1 Cross-cut saw with handles and set in case	10				
5 Measuring rods, 5-ft. ...	1				
	90	8		92	4

No. 8 MULE.

	lbs.		lbs.
1 Grindstone	60	6 Hambro lines	18
1 Farrier's bag (complete) ...	15	56 fms. 2-in. rope	45
1 66-ft. picketing line	7	Lashings (48-ft., 2-in.; 150-ft., 1½-in.; 60-ft., 1-in.)	20
	82		83

No. 9 MULE.

40 fms., 2½-in. rope	60	2 Blocks for 2½-in. rope	31
Iron wire soft	10	70 fms. 1½-in. rope	35
		Iron Wire, galvanized	1
	70		67

No. 10 MULE.

1 Box, iron	12	1 Box, iron	12
1 Exploder	30	Guncotton, 1 tin	25
220 yds. Cable	16	Auger and case	5
8 Tins, primers (10 in each) ...	8	220 yds. Cable	16
		1 Tin, Detonator No. 8 ...	1
		1 ,, No. 13 ...	1
		2 Tins, safety fuse	3
		2 ,, rubber tape	1
		2 Tubes, rubber solution ...	½
		1 Brush, 3 boxes matches ...	½
	65		65

No. 11 MULE.

1 Box, iron	12	1 Box, iron	12
8 Tins, ammonal	56	8 Tins, ammonal	56
1 Tin (25) No. 13 Detonator ...	1	1 Tin No. 8 Detonator	1
1 Tin safety fuse	1½	1 ,, Safety fuse	1½
5 Boxes matches	1		
	71½		70½

No. 12 MULE.

1 Box, iron	12	1 Box, iron	12
2 Tins, guncotton	50	2 Tins guncotton	50
4 Tubes, rubber solution ...	1	Box, testing and jointing ...	18
12 Friction tubes	2		
3 Tin safety fuse	4		
2 ,, No. 8 Detonator ...	2		
4 Guncotton bags	4		
2½ Tins, primers(25)	2		
	77		80

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No. 13 MULE.

Near.	lbs.	Off.	lbs.
1 Box, ammunition	77	1 Box, ammunition	77

No. 14 MULE.

1 Pump	85	2 Suction hose	68
1 Strainer	12	1 Delivery hose	15
		Handles and spanners	15
	97		98

No. 15 MULE.

1 Packhal (water)	90	1 Packhal (water)	90

No. 16 MULE.

Officer's kit	63	4 Dixies	35
Spare blankets		1 Shovel	5
Spare pack cover		1 Felling axe	6
		1 Pick	7
		1 Axe, hammer headed	2
		1 Set butcher's implements, 1 Tin opener	8
	63		63

No. 17 MULE.

Spare Mule to carry spare Kajawahs.

STORES CARRIED BY HEADQUARTERS DIVISIONAL ENGINEERS (2 LIMBERS) FOR EACH FIELD COMPANY, R.E.

Stores.	lbs.
5 Hooks, reaping, large ...	7
16 Axe helves, 36-in.	47
4 Shovel helves, curved, 32-in....	8
1 Adze, carpenter's, handle ...	1
1 ,, head ...	3½
20 Augers, assorted :— 5 1½-in., 5 1¼-in., 1 1⅛-in., 5 ⅞-in., 4 ⅝-in.	49
7 Auger handles, 5 18-in., 2 16-in.	3
8 Awls, blades, brad, 1 ,, handles, large ...	¼
1 Bevel steel blade ...	¼
1 Brace, carpenter's, ratchet ...	5
4 Brushes, sable, writing, large, 4 ,, ,, small, 4 Bars, boring, 4-ft. ...	68
4 Crowbars	80
10 Boxes, guncotton	250
38 Chisels, brick, 11 18-in. firmer, 1 1½-in., 1 1¼-in., 1 1-in., 4 ⅞-in., 1 ¾-in., 5 ⅝-in., 1 ½-in., 5 ⅜-in., 1 ¼-in., 1 ⅛-in. hand, cold, 6 ¾-in. by 8-in. ...	45
12 Files, assorted	37
8 Hammers, mason's, mash ...	34
8 ,, miner's, boring ...	64
4 ,, spalling ...	48
1 Saw, hand, 26-in.	2
1 ,, pit, 7-in.	15
1 ,, tenon, 14-in.	1½
6 Spanners, adjustable, 15-in. ...	25
4 Mikometer, G.S. (sets) ...	36
Ratchet brace and drills ...	28
Carried forward	857½

Stores.	lbs.
Brought forward ...	857½
1 Lines, white, 1 skein ...	1
1 Vice, hand, 16-oz.	1
1 Wrench pipe, ¼-in. by 2½-in. ...	10
11 Borax	1
4 Marine glue	4
2 Pints, oil, linseed	1
½ Gallon, oil, sperm	½
7 Lbs., Paint, black, ivory ...	8
7 Lbs., lead, white	8
7 Lbs., tallow	8
4 Pints, turpentine	4
2 Tins, oil, screw, top, 2 qts. ... 1 ,, ,, 1 qt. ...	15
7 Boxes dubbin	7
1 Lb. tacks, copper, ½-in. ... 1 Jack, lifting, G.S.	31
Pump spares :—	
8 Lengths, suction hose ...	280
8 ,, delivery	120
8 ,, 2-in. diam., 15-ft. canvas hose...	64
4 Lengths 4-in. diam., 6-ft. canvas hose	24
1 Rope, picketing	6½
4 Hose, binder's	1
2 Clarkson chests to carry small gear	48
4 Tapes, measuring, linen, 100-ft.	4
1 Flat iron and stand ...	5
5 Yards, canvas, 30-in. ...	6½
	1516

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JOINTED CHESSES.

By LIEUT. G. R. PERCY, M.C., R.E.

IT was decided many years ago that the only timber which combined the qualities of durability, hardness, freedom from knots, and closeness and evenness of grain, necessary in an article so heavily used as the chess, was Kauri pine.

As the finest quality of Kauri comes from New Zealand, shipping difficulties during the war caused a shortage, and as, in addition, it is estimated that approximately 30 per cent. of every shipload of Kauri received in this country is either too small in size to convert into chesses, or else is taken up by the waste pieces resulting from their cutting, it became necessary to devise methods of getting the utmost value out of such supplies as were available, in order to meet the constantly increasing demands for chesses from overseas. The most successful of these methods having proved to be the "Jointed Chess," it is thought that prominence might be given to it in the *Journal*.

The jointed chess (*Fig.* 1) is composed of either two or three narrow pieces of Kauri, glued together to make up the requisite

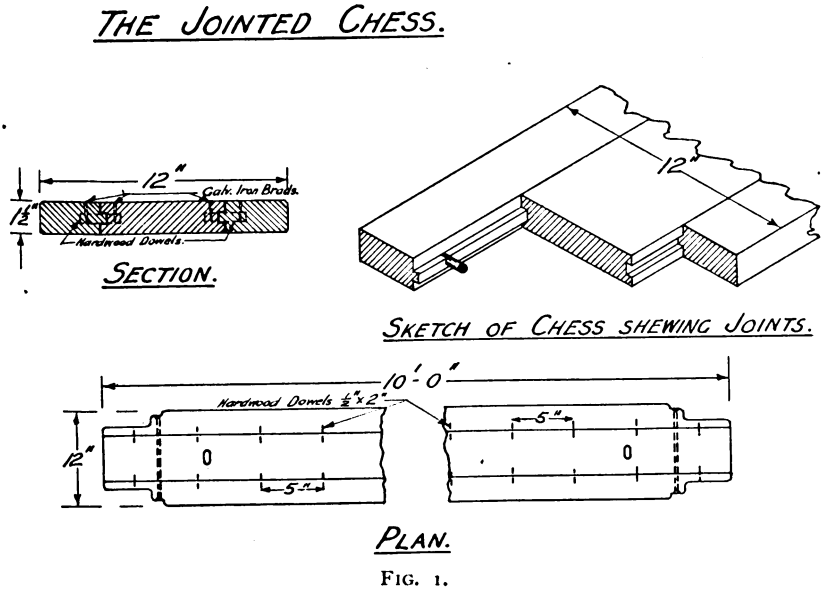

FIG. 1.

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width of 12 in. In order to render them absolutely proof against a sudden shearing strain, the joints are also tongued and grooved together, with the addition of hardwood dowels inserted at intervals of 5 in. along the joints and pinned with galvanized iron brads, to minimize the likelihood of transverse warping, and to prevent any possibility of the joints opening. In addition, there are of course the usual tie rivets at the ends, as in the solid chess. By this method, a chess as strong, and very little heavier than the ordinary solid chess, is produced.

One great difficulty however, was that the ordinary bone or fish glue employed became more or less solvent when exposed for any length of time to the effects of water, a common enough occurrence under Active Service conditions. To overcome this difficulty, various experiments were tried, culminating in the adoption of "Casein waterproof glue." The following description of this glue, and of tests carried out on it at Woolwich, may be of interest to engineers generally.

The glue, which is obtained in powder form, consists of a mixture of casein and alkalies, the proportion of casein being about 10 per cent. The powder is mixed with 1½ times its own *weight* of *cold* water, and stirred until a smooth paste results. It is then ready for use, and should be applied to the surfaces of the wood (which must be quite dry), with a broad spatula or similar tool, as its caustic properties destroy the hairs of a bristle brush. After the application of the glue, the joint is cramped up in the ordinary way.

For testing purposes, four plain *butt* joints were made up in Kauri pine, as follows :—

Sample No. 1.—Joint made with *ordinary glue.*

Sample No. 2.—Joint made with *casein waterproof* glue, mixed with 1½ *times* its own *weight* of water.

Sample No. 3.—Similar joint to No. 2.

Sample No. 4.—Joint made with *casein waterproof* glue mixed with an *equal weight* of water.

After sufficient time had been allowed for the setting of the glue, sample No. 2 was soaked in water at a temperature of 100° F. for 150 hours. The four samples were then cut, transversely across the joints, into strips 1 in. wide (in the direction of the grain), and 1½ in. thick, *i.e.*, the thickness of a chess.

Twenty-eight days after the joints were made, several of the strips cut from samples 2, 3, and 4 were immersed in water for 30 minutes, after which the whole of the strips were tested by placing them with the glued joint midway between two supports, which latter were 1½ in. apart, and applying a gradually increasing pressure to the upper side of the joint (*Fig.* 2). The result of these tests are tabulated in *Fig.* 3.

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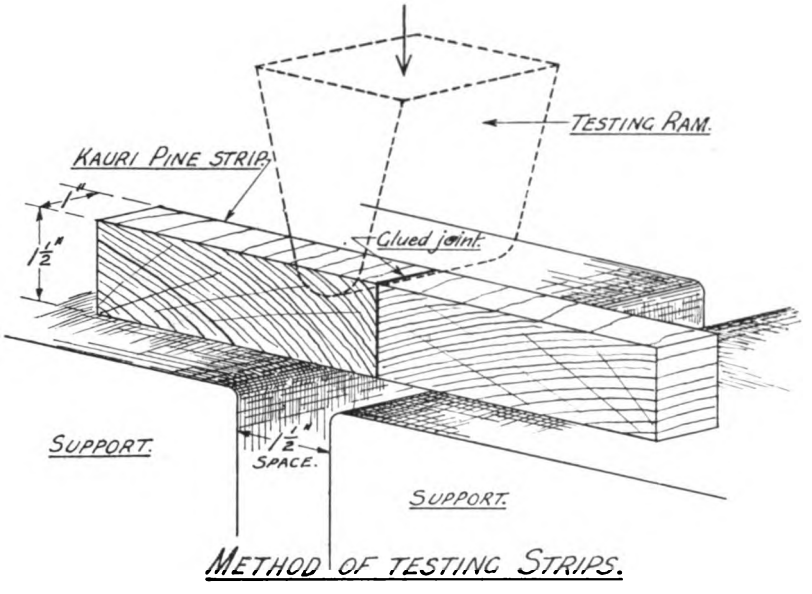

FIG. 2.

TESTS OF SAMPLE GLUE JOINTS IN KAURI PINE.
STRIPS OF 1 Sq. INS., SECTIONAL AREA.

SAMPLES.	No. of STRIP	ACTUAL BREAKING STRAIN IN LBS.	BREAKING STRAIN IN LBS. PER SQ. IN.	NATURE OF FAILURE (WHETHER IN WOOD OR GLUE.)	REMARKS.	No. of STRIP
Sample No 1. (Joint made with ordinary Glue.)	1	784	523	Glue.	Not immersed in water.	1
	2	761	507	Wood.	Do. do.	2
	3	716	477	Glue.	Do. do.	3
	4	604	403	Glue.	Do. do.	4
		Avge. 716	477			
Sample No 2. Joint made with Casein Glue (1 part) Water (1½ parts) by weight.	1	604	403	Wood.	Immersed in water at a temperature of 100°F., for 150 hours. No further immersion.	1
	2	515	343	do.	Do. do.	2
	3	582	388	do.	Immersed again before testing for 30 minutes.	3
	4	437	291	do.	Do. do.	4
	5	515	343	do.	Do. do.	5
	6	604	403	do.	No further immersion.	6
	7	618	412	do.	Do. do.	7
		Avge. 554	369			
Sample No 3. Joint made with Casein Glue, mixed as in No 2.	1	1164	776	½ Wood, ½ Glue.	Not immersed in water.	1
	2	1187	791	Wood.	Do. do.	2
	3	1097	731	do.	Immersed before testing, for 30 minutes.	3
	4	985	657	do.	Do. do. do.	4
	5	963	642	do.	Do. do. do.	5
	6	1142	761	do.	Not immersed in water.	6
	7	1120	747	½ Wood, ½ Glue.	Do. do.	7
		Avge. 1094	729			
Sample No 4. Joint made with Casein Glue, 1 part: Water 1 part: (by weight)	1	403	269	Wood.	Not immersed in water.	1
	2	492	328	½ Wood, ½ Glue.	Do. do.	2
	3	627	418	Wood.	Immersed before testing, for 30 minutes.	3
	4	492	328	Glue	Do. do. do.	4
	5	649	433	Wood.	Do. do. do.	5
	6	515	343	Glue.	Not immersed in water.	6
	7	403	269	Glue.	Do. do.	7
		Avge. 512	341			

NOTE:— Strips 3, 4 & 5, from Samples 2, 3 & 4, were 2 inches wide when immersed for the 30 minutes, but before testing, ½ inch was cut off from each side, thus bringing their width down to 1 inch. (The same as all the other Strips.) This was done to minimise the effect of the extra percolation of the water on the end grain.

G.A.Perrin

FIG. 3.

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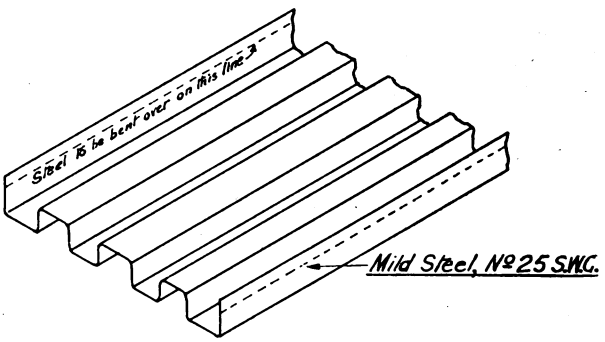
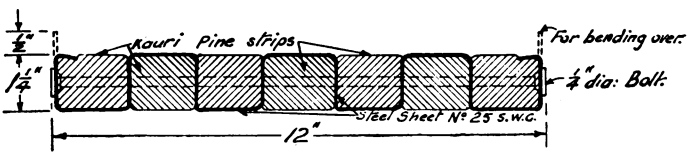
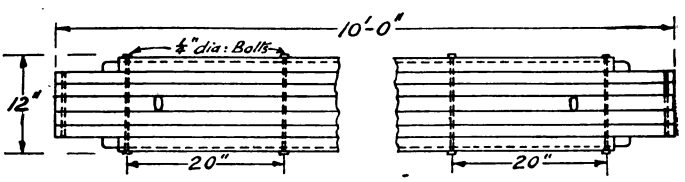
THE CORRUGATED CHESS.



CORRUGATED STEEL SHEET.



SECTION THRO' CHESS.



PLAN.

FIG. 4.

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It will be seen that the soaking in hot water of sample No. 2 had no apparent effect on the casein glue, as in the case of every strip from this sample, failure occurred in the *solid wood* adjoining the joint, the glue successfully withstanding the strain. The 30-minutes immersion in water just prior to testing, had likewise, no effect on the glue. In sample No. 3, no failures occurred entirely in the glue, but two strips failed—half in the glue, and half in the adjoining wood. The remaining strips from this sample failed entirely in the solid wood. The mixing of the casein glue with a lesser proportion of water than advocated above, was not a success in sample No. 4. It may be noted, however, that the glue in the strips from this sample which were immersed before testing, appears to have been strengthened, rather than otherwise, by so doing. The tests of the ordinary glue in sample No. 1 resulted in three of the four failures occurring in the glue itself.

In conclusion, it may be stated that the jointed chess, when put together with casein glue, is undoubtedly a very valuable means of supplementing the supply of chesses, and of using to the best advantage the smaller sizes of Kauri pine.

Finally, a brief reference must be made to another war substitute—the "Corrugated chess" (*Fig.* 4) which utilizes even smaller strips of Kauri than the jointed chess. The corrugated chess is a composition of steel and wood. A sheet of mild steel, No. 25 S.W.G. is rolled to the corrugated form shown in *Fig.* 4, its finished sizes being the same as those of an ordinary chess, except that it is 1¼ in. instead of 1½ in. thick, in order to keep down the weight as much as possible. Strips of Kauri pine of the same length as the steel are then inserted into the corrugations, and the whole stiffened by bolts of ¼-in. diameter, spaced 20 in. apart. Several disadvantages, however, which up to the present have prevented its general adoption, are attached to this form of chess. Chief among these are its somewhat heavy cost (special rolling mills are necessary for the steel), the difficulty of fitting the steel down to the outside strips of Kauri, and the difficulty of making the bolt holes in steel and wood exactly co-incident. It is also from 8 to 10 lbs heavier than the ordinary chess.

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FUTURE TACTICS.

By BRIG.-GENERAL A. L. SCHREIBER, C.B., C.M.G., D.S.O., A.D.C.

IT may seem somewhat premature so soon to consider what the future conditions of modern fighting will be, but any ideas, however crude, on the subject may be of some utility. It must be understood that the following is put forward to give an indication of the lines on which thought and discussion are now needed, rather than as an attempt to formulate a conclusion.

After our great successful advance in France the trend of war training has turned naturally almost entirely, as it was before the War, to the attack; and there is little doubt that we have arrived at the right conclusions (copied from the Germans) of pressing home the attack wherever "soft spots" in the enemy's defence are found.

The training of troops must of necessity be for the attack but the danger is that as before the War, the principles of defence may be neglected, and this in spite of our having had to act for four years on the defensive. There is no doubt that we suffered greatly, and might have suffered more, from the fact that the necessary conditions of defence had been ignored.

I remember well how immediately after our arrival near Mons, we had to prepare at once to act on the defensive and took up a position, in a half-formulated system, of *points d'appuis* or small defended localities. These were so weakly held, and were so far apart for such an enclosed country, that there is little doubt they would have been over-run in a very short time; fortunately we had to retreat before being attacked in that position.

The principles of defence had only been studied by few; practically every thought in training had been devoted to the attack. We must beware of this again occurring.

Is it not possible that after the preliminary fighting two opposing forces may not again remain for a long time practically equal in *morale*, numbers, and armament till such time as some deciding factor gives sufficient preponderance to one side or the other, in fact may not the conditions of this War be again repeated? If there is the chance, the principles of defence require very earnest study, and a very difficult problem is presented.

In any case with large armies in order to take the offensive with the largest possible strength in the required portion in the war area, the best possible system of defence must be established to hold the other parts with minimum forces. It cannot be too strongly emphasized that it is the side which is able to build up the strongest, the best trained, and the most mobile reserve which is

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going to win, and the stronger and the better the defensive system, the greater the facilities for carrying this out.

For three years at least we played a game of bluff—so did the French—so did the Bosch. Both sides held far greater fronts than by all the rules of war were conceivedly practicable. The chief axiom for the offensive—defensive, which all this time both sides were attempting, was that there should be a general reserve equal at least to the total number of troops in the defensive zone. Ours was practically *nil*, the French and the Bosch were more or less in the same state till the latter had accumulated troops from Russia in March, 1918. After that the stable defences on the whole ceased, but even then whenever the fury of fighting had died down for a time in any part, the old conditions began to reassert themselves.

At the present time it is hard to concentrate the imagination on what future conditions may be, as certain important factors of change have developed which will be mentioned later. One has a feeling of groping along well-known and well-remembered streets in a fog.

If fighting began to-morrow and we had to act on the defensive, what system should we try to establish ?

First let us study the evolution of defence in this War.

As stated above we started with a half-formed system of *points d'appuis*. We then had open warfare, first in retreat and then in advance, till we were stopped on the Aisne. What happened then ? We were stopped in our attack and had to dig in—either on the line we had reached, or behind it in places where our infantry was swept off the crest of the ridge by enemy's shrapnel. We dug in, gradually joining up the trenches till they formed a continuous line. The reasons for this were :—

First—every rifle possible was required in the front line to prevent the enemy crossing what soon became the " No Man's Land " 100 yards in width.

Secondly—the Bosch penetrated the intervals, and, incidentally, as a minor item, snipers crept through and were a nuisance, and

Thirdly—to allow of lateral communication.

We dug in, we deepened the trenches, we improved them, we increased the traverses where they were enfiladed, we put what wire we could in front, we dug support trenches and connected them to the front, and we dug holes in every available nook and corner we could find for the men to rest in. We had a desperate time, and then handed over to the French. That defensive line remained, I believe in exactly the same place for over three years, till the Bosches carried out their big " push " in 1918.

This is what happened on the Aisne and subsequently on the whole original British front from north of Ypres to Quinchy on the La Bassé Canal.

All our defences were begun on the field of battle. We always started attacking on what by all the rules of war, were ridiculously

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ROADS.

By LIEUT.-COL. A. G. T. CUSINS, R.E.

IN view of the vast demands on transportation generally which an army of modern times is enabled to make by reason of the capabilities of mechanical transport, and of the wear and tear of roads involved, it may be of interest to record the methods adopted on the Serres Road running from Salonika to the river Struma.

It may be taken for granted that transport will be expected to work up to the limit of its capabilities, and roads must be constructed accordingly. Before the war very little was known in the service, and experience was limited out of it, on the subject of the action of heavy rubber-tyred vehicles in the disintegration of road surface. To this subject these notes are devoted.

The Serres Road, running north-east from Salonika, was before the war doubtless considered a good road, that is to say it was fairly well located, but like all roads in hilly country somewhat tortuous, and sufficiently metalled to stand the light traffic of the country and to present to the casual observer the appearance of solidity. So it remained until the commencement of the winter of 1916–17, but steadily deteriorating all the time and giving increasing trouble, especially across the Langaza Plain, and on the foothills beyond, from about the 13th kilometer post (General's Corner) where it passed through the old "Birdcage" Lines, the Torres Vedras of the campaign, up to about the 27th kilo. post. This portion was on a treacherous alluvial clay, comparable in places to anything Flanders can offer, and at the best a highly viscous fluid. No clay, however apparently hard, can ever be treated as a solid, as I think Robert Stevenson remarked; if it cannot move in any other direction, it will move upwards. For the rest up to the 43rd kilo. post, which was the limit of my area, the bottom was sound and ranged from gravel to actual cutting in quartz. So much for the bottom.

Metalling was fairly plentiful and accessible. There were two good quarries of hard limestone, practically unlaminated and non-absorbent, about one kilo. from the road near Lembet at about the 6th kilo.; a very good quarry of hard but somewhat brittle limestone very non-absorbent and resembling a hard marble at Deve Kran (Gibraltar Hill), three and a-half kilos. from the road at about the

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18th kilo.; a patchy and not at all easily worked quarry at kilo. 34, a somewhat similar quarry at kilo. 37, giving a hard but somewhat laminated limestone; and a small quarry of good granite at kilo. 41. These last three quarries were fairly close to the road. There was no difficulty about soling stone, which was plentiful.

The main difficulty in connection with stone supply was that the transport requirements were hard to drive home to the Transport Staff, and it took time and bitter experience to establish the axiom that for any road to be maintained under heavy transport there is a definite proportion of that transport which must be devoted to maintenance.

I do not write this in any carping spirit. The long continued dry weather of 1916, and the consequently fair condition in which the road remained on the whole, produced a sense of false security and was a very bad preparation for the state of affairs which followed immediately on the setting in of the winter rains. The gloomy prophet met with about the success of his local predecessor, Cassandra, and had the same gloomy satisfaction.

Previous to this however, the first four kilos. of the road, having not only to serve one complete British Corps at the front but also to deal with heavy French and British traffic from the docks to the large base camps and dumps, had given ample opportunity for observation and experience. Part of this portion also had an unsound bottom, being in places on clay, as near the Allied Cemetery, a portion of it on a made embankment, and in one place, a very narrow strip into the bargain, actually running through an old Turkish cemetery over badly filled graves. Over this portion of the road traffic was counted, and amounted to 30 vehicles per minute for three hours in the forenoon, a large proportion consisting of heavy mechanical transport.

Observations.

It was on this that observations were taken, and from those observations certain theories were evolved and checked. It must be borne in mind that the road was entirely water-bound, as no tar was to be had, and that no other method of surface treatment was possible except the application of oil to keep down dust in the vicinity of hospitals. But this did not materially affect the construction. It was observed:—

(1). That the wear of metal was very much less on the surface of the road than just below it. This is to be expected. The action of a heavy rubber-tyred vehicle is not to abrade the surface but to cause local compression and consequent grinding together of the upper three or four inches of the metal.

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(2). That where the surface metal was small, *i.e.* 2 in. and under, the movement and flow of the metal was more marked, key was sooner lost, and mud and dust formed more rapidly in consequence, than when the metal was large, *i.e.* $3\frac{1}{2}$ to $4\frac{1}{2}$ in. Moreover, that the smaller metal favoured the production of potholes and the formation of regular corrugation and was more easily picked out by fast cars.

(3). That potholes and corrugation both appeared much sooner on a clay formation, even when apparently hard and dry, than on gravel or other sound formation.

(4). That a more or less complete break up of the metalling followed close upon the appearance of anything like numerous potholes or of regular corrugation, and that the metalling so broken up was almost invariably rounded at the edges and generally deficient in key.

(5). That, as is generally known, more damage was caused in wet weather than in dry, and most of all on the break up of frost, but that in any case the damage was considerably less in the case of the large metal.

(6). That there is very little rocking of individual surface stones under heavy rubber-tyred traffic.

(7). That too much camber causes drivers to keep almost entirely in the middle of the road. Lorry convoys always tried to "track," *i.e.* to follow the same wheelmarks. The effect of this is if anything more marked in the middle of the road than towards one side, as the tracking is more regular.

(8). That drainage of the formation is as necessary as that of road surface, and that the surface of the formation requires protection against indentation. This is particularly the case where clay occurs, as irregularities retain water and cause local softening.

(9). That mechanical stone crushers, when used on any but very hard homogeneous stones quite devoid of lamination, produce flake-shaped metal unsuitable for surfacing. Moreover, that the stone in addition to being broken is structurally crippled and rendered prone to subsequent disintegration.

Much of the above may be ancient history, but it constituted the data on which what proved in the result a successful system was built.

From (3), (4), (5), and (8) we see at once that stability is required and that it must begin from the bottom upwards. The first thing to do is to produce a well-drained formation, and on that formation to distribute the weight as widely, evenly, and steadily as possible. In the worst cases therefore, the existing road surface itself, scarified and rolled if necessary to produce a good drainage surface, was used as the formation, and on this a soling of block stone as cubical in shape and as even in size as possible, was hand-packed, always using

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the largest surface downwards. Where it was exceptionally desirable to protect the drainage surface, a blanketing of 1 to 2 in. of small quarry rubbish was used for bedding the soling. The heaviest soling of this type put in was 10 in. deep in one thickness. It was found to be best to employ the local mason, who is skilled in dry stone walling and of superior intelligence to the ordinary " Idey Bross " or labourer. This soling was contained laterally by a continuous kerb of long stones placed on end in a narrow trench, the tops of the stones coming to the level of the finished road. This system is of course only possible where there is a plentiful supply of stone over 2 ft. in length. Still longer stones may be used at intervals to mark the edge of the metalled portion. The kerb trench itself must be drained to the side ditches. Before metalling, but after inspection, the soling was hand-spalled up to rough level, lightly blanketed with small stone rubbish and rolled to consolidate it. Hand-broken metal was then laid and rolled in two thicknesses, the first being rolled to consolidation, the second to surface. The finished thickness of metal after rolling was about 8in.

A good many objections were raised to the use of large-sized metal :—It would not roll ; it left too many voids ; stones would rock and work loose ; the final result could not be more than a cobbled surface ; and so on. Experience showed that it could be rolled even as large as 5 in. If of a good solid shape and not flaky it filled in well in the rolling, and if voids exist I do not know that they matter much. They certainly aid in keeping the surface clean. Owing to the length of side of each stone, its moment of resistance to turning is considerable and rocking is prevented. Consolidation is good, kneading is absent, and corrugation does not occur. The importance of this last is incalculable in terms of upkeep of both road and vehicles. The surface tended to become slightly cobbled in places, particularly on steep hills, but lorries rather liked it as it reduced the chance of skidding, and fast cars did not complain of it. Small metal, moreover, is pulled out by fast car traffic. The sole of a rubber driving tyre is strained forward where it is in contact with the road, and is released backwards as it leaves it, rolling out small stones and actually throwing them back as from a catapult. On a sharp curve this action takes place sideways as well.

In one place, on a steep hill where during the worst period of the road's history its condition very nearly resulted in complete breakdown, the worst of the mud was dug out and large stone, the smallest 4 to 6 in., was just shot in to find its own bed. This consolidated so well under traffic—there were then no rollers—that it was left until almost the last for permanent repair, and though rough and untidy to look at never developed either potholes or corrugation. Water was only used with the surface binding material which was

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not applied until the surface itself had begun to consolidate dry. The binding was then watered to a slurry whilst rolling was in progress. The binding material itself should vary with the nature of the fracture of the stone. River gravel should only be used with the rougher kinds of crystalline stone, such as granite, while with stones having a smooth fracture a more cohesive binding such as decomposed granite or bed gravel is preferable. A little thought will make this obvious; a hill wind shows it at once. Unsuitable binding may be blown right out.

DRAINAGE.

There are three main rules for drainage :—

(1). Start with your road as dry as possible.

(2). Keep it so.

(3). Get the water from the road as far away as possible.

Side ditches should be not less than 6 ft. from the edge of the metalling and their bottoms not less than 1 ft. below formation. They should be V shaped, and not more than 1 ft. wide at the bottom. The saving of labour in clearing silt when a V-shaped ditch is adopted is surprising.

On sloping ground, the road must be located if possible so that the cross section gives a fall of natural clearance, *i.e.*, that no silt accumulates in culverts or in the drains leading away from the road. Considerable trouble was experienced from the fact that the existing road, where crossing a plain at the foot of the hills, was at such a level that the cross section was insufficiently inclined to carry away silt.

Springs and oozing seepage are serious difficulties. They can be dealt with however by lowering the bottoms of side ditches, and tapping the formation by means of perforated pipes driven with a pipe pusher.

As regards the road surface, it was found best to allow water a clear run from the crown of the road to the side ditches. Banking the sides " to support the road," nearly always results in supporting two continuous quagmires to destroy it. The muddy ruts formed by vehicles passing each other constitute a series of parallel dams and prevent drainage. The ruts, moreover, are always worst at the water-cuts through the bank. Any ruts which form at the edge of the road should be flattened out at once, and especially those made by occasional wanderings off the metalled portion. This is often neglected, as the intimate connection between tidiness and efficiency is not always realized.

Camber must be kept to a minimum to prevent " tracking." Especially is this the case with inferior limestones which produce a mud on which one can hardly walk safely. I remember a lorry

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on the Monastir Road, which was level but rather overcambered, skidding slowly round as it tried to regain the middle and finally sliding right off the road backwards. The driver's only comment was " I now know why this —— country is called Greece." Camber must not be allowed to degenerate into barrel, but the road should if possible consist of two slopes of not more than 1 in 30. More than this leads at once to tracking, and the deterioration due to this and to lorries continuously making a steady amount of leeway is apt to be serious. The effect of barreling is to accentuate the evil at the edges of the road, the worst possible place. Unfortunately many men with road experience seem to have been brought up on barrel as opposed to even camber. The rounding off of the crown of the road need not be more than about 6 ft. wide.

Throwing open New Road.

The first month of a new road's life is the most critical. Nothing can consolidate roads so well as traffic, and on the other hand nothing can do it more harm. The main thing is to try and prevent " tracking " and to distribute the traffic as much as possible. This was affected by " groining " with trestles, sandbags, etc., the groins being moved along the road at intervals, the effect being to cause traffic to undulate from side to side and distribute its consolidating effect to the utmost. It is greatly to the credit of the Motor Transport that they tolerated this imposition without a murmur.

Transport of Stone, Water, etc.

Owing to the strictly limited amount of transport available every effort was made to utilize it to the utmost. Having since observed the handling of stone in France I am of opinion that the motor vehicle used, a design borrowed from the French, was out and away the best. It was made by building a W-shaped iron body on a 3-ton lorry chassis. Each side was hinged at the top, and the two hoppers, each holding 1 cubic metre or 1½ tons, could be emptied in about half a minute. The space between the hoppers is useful for the lorry gear.

At the quarries, stone was loaded from staithes and platforms downwards, not upwards as I have seen in some other areas, and the loading took rather under 2 minutes. Assuming that lorries were running one hour per trip, this means that they were standing still, or doing nothing but block traffic, for only about 4 per cent. of their time.

Four-mule double limbers, the vehicles lined with sheet iron, carry one ton. The utmost that could be got out of one double limber was 14 kilo. tons per diem, 28 kilos. in all, and this only by rapid loading from platforms, and by resting the men and animals well at

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mid-day. If possible, a space was kraaled near water and trees, and the mules were turned loose, stripped of harness and allowed to graze and roll. More work than the above tended to reduce conditions.

Men should have shelter, and cooked meals be sent to them.

Native carts, ox and pony, are best kept to soling stone, the former on account of their construction, and both because less is lost on the way. In any case, contract drawn stone must be measured at site of delivery. Use was also made of empty supply lorries; these are slow to load, but times was saved by backing them to platforms and loading the stone in sandbags. On the average a sandbag does about two trips. Decauville railway, 60 cm., was also employed in places, but rolling stock was very scarce and got badly knocked about. The Macedonian loves joy-riding and has no discretion.

Brass bearings are useless. A good makeshift roller bearing was improvised by driving short lengths of 3-in. pipe through hard wood blocks, with two cover plates, the inner one pierced for the axle. The space between the axle and the pipe was packed with short rollers, cut from ordinary mild steel of suitable thickness, which lasted far better than might be expected.

A few motor water carts were available. These were used for carrying water, ordinary horse water carts for sprinkling. Distance from water was at times considerable.

LABOUR.

The native of modern Macedonia is the survival of the idlest. The slightest industry on that soil with that climate produces wealth, and the national pastime of throat-cutting applies the corrective. But given security, cupidity triumphs. The ideal of course is day work, or pay for working only while you are carefully watched. But piece work achieved the miraculous. The first week of it at rates calculated at half-day work bade fair to ruin the British Empire. But when rates were more scientifically fixed it was found advisable to reduce everything to this system. Men and boys were employed on all but breaking metal, which was done by women and girls.

Every process, ditching, forming, soling, spreading, spalling, etc., was treated separately, and the hands were paid individually or in small gangs as suited best. Details must vary accordingly to circumstances, but I would strongly advise R.E. officers, in the near East at all events, to adopt this method when working against time.

ROLLING.

Rolling went on night and day. New work by day, recently completed work open to traffic by night. It does much good to continue

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rolling new work while still green, as it gets rid of incipient rutting and the uneveness inseparable from having to make the road one side at a time. The roller drivers worked in three reliefs.

The 43 kilos. of road so rebuilt were commenced in February, 1917, and completed in June, 1917. A letter dated November, 1918, from an officer well qualified to speak, tells me that "the Serres Road has been used right through. The British Salonika Force has never been able to get away from it. It now lasts without any repairs." As it was for many months the sole line of communication for one British Corps, it seems to have met requirements.

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CORRESPONDENCE.

FUTURE OF PERMANENT FORTIFICATION.

TO THE EDITOR OF THE *R.E. Journal.*

SIR,

Lieut.-Colonel Clayton has raised a large question in the heading of his article. It is this, except for coast defence does Permanent Fortification exist? Lieut.-Colonel Clayton's article was written to raise discussion, and I venture to start the discussion with this question.

2. After my experience in the present war I am of opinion that permanent fortification as we understood it formerly is as dead as the Pharoahs. I do not mean its principles but its methods. The principles upon which men start out to kill each other are much as they were, but our methods of application change and must continue to do so.

3. The office of fortification is to first facilitate the destruction of the enemy and second to protect the troops from destruction.

To facilitate the destruction of the enemy mobility is essential and permanent fortifications are immobile. During this war it has been often found that even field defences, carefully prepared and sited to meet possible eventualities, were useless when the time came, as the enemy did not come the way he was expected. Permanent shelters and stores, *et hoc genus omne* must follow the distribution of the troops, and if that is not permanent it is waste of time and money to make the shelters, etc., so either.

4. Generally speaking I think the defences of a Territorial area should before war be dealt with under the following headings:—

(*a*). *Communications.*—Rail and road to be strategic in arrangement, and also be arranged with commercial objects. No modern army can operate without railways and good roads.

(*b*). *Distribution of Forces.*—To meet various situations. These with the defensive works should be on paper. As regards works—Alternative schemes should be designed and planned, and these should include works of defence gun positions, roads, light rail and extension of heavy rail, shelters, dumps, etc., etc. Stores should be accumulated at suitable points so that the army may put the selected scheme in operation at short notice.

5. Engineer officers must remember that all military action will commence with open fighting as a general rule, and that the decisive battle in the end will be an open one. Fortifications will only be used for special purposes, *e.g.*, to enable a small force necessarily immobile, to secure some definite point, or to enable an army to gather strength to assume the offensive in the open, as was the case with the Allies in the war. Even in the former case it is most likely that field works are the best form to use.

6. As regards Anti-Aircraft Defences it seems likely that in the future it will be largely if not entirely in the air. Fixed defences may be used, but even they will not be of a definitely permanent nature.

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They will have to be fairly mobile and the construction of bomb-proof shelters and stores in time of peace is, I believe, a mistake as is likely to be the defence to positions which when the time comes may not be the most suitable.

Fixed defences, hutments and stores have been constructed during this war to meet a definite set of circumstances, but that is no guarantee that they will be suitable the next time.

7. I do not touch on coast defence, but even here the mobility of the larger natures of ordnance has increased so much lately that it seems very doubtful if our old ideas of a coast battery are not quite out of date, except in very special cases, such as in batteries sited actually in the sea.

Yours faithfully,

G. WALKER, *Brigadier-General.*

SIR,

1. With reference to the article on "The Future of Permanent Fortification" published in the February issue of the *R.E Journal*, it is suggested that a discussion on this subject might be based on consideration of the principal changes and developments in the methods of war recently introduced. At the same time it should be remembered that the principles of war as generally accepted in 1914 remain unchanged.

2. It would appear possible to group these changes, as far as *Land* fortification is concerned, under three general headings:—

(1). *Influence of Aviation*:—
  (*a*) Extended powers of reconnaissance;
  (*b*) Offensive action.

(2). *Development of Armaments*:—
  (*a*) Increased power of artillery;
  (*b*) Tanks.

(3). *Changes in the Time Factor*:—
  (*a*) Rapidity of action of aircraft;
  (*b*) Improved communications.

3. The question for the military engineer now resolves itself into "How are these new factors in the offensive to be met?"

(1). *Influence of Aviation:*

(*a*). Extended powers of reconnaissance—necessity for greater concealment. Camouflage to be studied in connection with aerial observation and photography; dummy works; many works hitherto constructed on the surface will be driven underground.

(*b*). Offensive action—consequent necessity for protection of
  (i.). Aviation units and grounds.
  (ii.). Centres of communication of all natures and delicate points in these, such as bridges.
  (iii.). Headquarters.
  (iv.). Depôts and factories of munitions and food.
  (v.). Accommodation for troops.
  (vi.). Centres of population, etc. (in order of importance).

The protection necessary will involve A.A. gun positions, range-finding and searchlight stations, in addition to the forms of material shelter which may be necessary in each case.

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(2). *Development of Armaments :—*

(*a*). Increased power of artillery—a large question, which is possibly better considered under subheads :—

(i.). Increase in range—any permanent works must be further from the object they are designed to cover than has hitherto been the case—greater depth of all positions.

(ii.). Increase in shell power—more material cover required—deep dugouts—reinforced concrete.

[Before condemning the masses of steel and concrete of the forts of Liege and Namur, it would appear of interest to consider the effect of the large concrete works of Verdun, the capture and recapture of which were undoubtedly expensive undertakings for the assailants in each case.]

(iii.). Increased accuracy and development of the means of range finding, notably by sound ranging, necessitating adequate cover and alternative positions for gun positions hitherto termed "concealed"; small works presenting a difficult target.

(iv.). Increase in volume of shell-fire—to be considered with (ii.) as regards destructive effect; limitation of movement. The development of short range weapons for the destruction of obstacles will also considerably affect the design of the latter—sunken wire.

(*b*). Tanks will necessitate "anti-tank" defences of all sorts—ditches, traps, mines, and gun positions.

(3). *Changes in the Time Factor :—*

(*a*). Rapidity with which an attack by aircraft may be made after a declaration of war will necessitate considerable preparations being made in peacetime to meet such attacks.

(*b*). Perfected means of rail and road communication will shorten the period between the declaration of war and the time at which the enemy will be prepared to strike. The time therefore available for the organization of schemes of defence will be shorter than in the past, and work of a permanent nature may have to be undertaken on a larger scale than has hitherto been the case to guard against surprise.

4. The case of the offensive having been considered, it is necessary to ask the parallel question "How are future fortifications to be designed so as to obtain the maximum efficiency from the new powers of the defensive—the highly-organized artillery, machine guns, and communications at our disposal?"

5. The above outline is put forward as providing headings under which the large subject of the "Future of Permanent Fortification" might be discussed from the point of view of the military engineer.

The greater problems of expediency and the general nature of fortification are General Staff questions, which no doubt in the future will be severely limited by political and economic considerations.

It may, however, be permitted to draw the general conclusion that protection against aircraft, considerably more powerful than that we have hitherto had to contend with, will be the first problem to solve in connection with the reorganization of our Permanent Defences.

Yours faithfully,

K. J. MARTIN, *Major.*

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REVIEW.

WATSON PASHA.

A RECORD OF THE LIFE-WORK OF SIR CHARLES MOORE WATSON, K.C.M.G., C.B., M.A., Colonel in the Royal Engineers. By Stanley Lane-Poole, LITT. D., assisted by Walter W. Skeat. London, John Murray, 1919.

Watson was very good company—full of information—full of humour—full of kindness. To say that he was " all things to all men " would be misleading, because that phrase generally implies a percentage of humbug, and Watson was not at all a humbug. Behind his pleasant talk, delivered in a delicate brogue, beat a heart as sound and true as in the most phlegmatic Englishman or the dourest Scot. All his friends, the few survivors of his early days, the many acquaintances of his " retired " but most active life—all will welcome this book. They will find probably some items new to them, and, throughout, will revive the recollections of a delightful personality. But, to those also who never knew the man, the book will be interesting. The Great War makes, it is true, all previous wars seem so small, and the changes in the world now under discussion seem so to dwarf all past history that the careers of even the greatest soldiers and statesmen of the past seem to shrink in importance as matter of study. But such feelings are illusions. Real history is always valuable. Biography is its most effective form, and the life of Watson is worth reading as the record of fifty years work—thirty-six on the active list as an exceptionally able and conscientious Royal Engineer Officer, and fourteen more engaged in public work of various kinds.

Early Life and Service (1844—1874).—Watson's family settled in Ireland early in the 18th Century. They were leading business men in Dublin, and several were distinguished graduates of Trinity College, so that Watson inherited a combined tradition of business and scholarship, giving him methodical habits and a wide outlook, two excellent qualities usually more wanted than found in those who follow the trade of war. He was born on July 10th, 1844, and educated at home, except for one year at a Dublin day school, and two years attending lectures at Trinity, under a good tutor preparing him for Woolwich. In July, 1863, he passed in first. Till joining at Woolwich he had never left home. He passed out also first, with prizes and distinctions. In 1866, in February, he took his B.A. degree at Trinity; his Commission was dated April 17th, and on May 17th, he joined as an officer at Chatham. Professionally he was, of course, a model young officer. His deficiencies were mainly in dancing and small talk. He dissociated himself from the Corps proverb by expressing his astonishment at " the mania for getting married." He matriculated in yachting under the superintendence of a brother officer (now Sir Elliott Wood), who describes an incident off the Nore deserving the careful attention of all who propose either to learn or to teach the sailing of boats. In 1868 he left Chatham. For six years he was employed on Home Service; 3 years on fortifications in Ireland, 2½ years at Woolwich and Sheerness on the experimental work of Submarine Mining.

In 1874 he was thirty years of age. His home life had been perfect. His education and early years of service satisfactory and promising, but he had still to come under the influences of the two men who most moulded his character, Sir Lintorn Simmons,

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one of the ablest military administrators of his time, and General Gordon, one of the greatest genius's of his own and of a good many other times as well. From Simmons he was to learn what wonders can be worked by tact and firmness, by (in the words of Lane-Poole) " level-headed governance " ; from Gordon, to " follow the gleam " of truth and duty wherever leading, to do with all his might the work in hand, whether congenial or uncongenial, recognized or unrecognized, and so to reach the best happiness life can give. Simmons was " just the right antidote to Gordon's enthusiastic impetuosity." Gordon was a hero of heroes, but difficult to serve and still more difficult as a subordinate. Simmons was a practical man. Watson had the great advantage of intimacy with both men.

With Gordon in the Soudan (1874–75).—In 1874 General Gordon was Governor (under the Khedive of Egypt) of the equatorial provinces of the Egyptian Soudan. He wanted two R.E. officers for survey work—Watson was chosen as one of them. He left England on July 29th, and, travelling, viâ Suakim, Berber and Khartoum, reached Gordon at Gondokoro on November 14th. He remained there till November 28th, when Gordon sent him on to Rejaf, where he got fever so badly that Gordon had to recall him. On the 31st January, 1875, he met Gordon again at Bor, and they travelled together down the Nile till February 9th. Watson then went on (with Colonel Burnaby as companion), reaching Khartoum February 16th. They rode on camels from Khartoum to Korosko, 600 miles in three weeks ; then down the Nile by boat to Assiut ; and on by train to Cairo, March 30th. Watson was back in London by May 1st, 1875.

The whole trip was only ten months, and of that time Watson was actually with Gordon only a little over three weeks. But the two men became the closest friends. Till Gordon's death, ten years later, they continually corresponded. Whenever Gordon was in England they continually met. Gordon, on his last journey to Khartoum, stopped in Cairo with the Watsons, who did everything they could for him. Gordon's last letter from Khartoum, December 14th, 1885, was written to Watson, and Gordon's memory became " part of his religion."

Gordon's peculiarities were, of course, just as obvious to Watson as to any one else. As an amusing instance of " Gordonese," Watson told how in 1880, Lord Ripon, on appointment as Governor-General of India, tried, in a weak moment, to get Gordon to go with him as Military Secretary. Gordon, in a moment equally weak, accepted the offer. When Watson met Gordon he expostulated with him, pointing out that he must know not only that the job would be uncongenial to him, but that he was himself totally unfit for it. Gordon agreed. So Watson made him sit down at once, and write to Lord Ripon that, on re-consideration, he must refuse. The letter went, because Watson himself posted it at once in case of further change. Lord Ripon, however, like the foxy old Khedive Ismail, knew Gordon's weak point and replied to the effect, " But you have promised. You, Gordon, cannot go back on your promise." And Gordon, veering, again consented. When next they met, Gordon's defence to Watson was (and here, said Watson, telling the story, came in a peculiar element in " Gordonese " psychology), " Well, I've promised to go and I'll go. But I shan't stop." And this programme Gordon put through without further change.

When, in 1880, Watson married, the banns were blest by Gordon in a rather pathetic note to Watson :—

> " A man who is not married cannot know his faults ; a man's wife is his faithful looking-glass ; she will tell him his faults. . . . Till a man is married he is a selfish fellow, however he may wish not to be so. . . . You say, ' Why do not you follow your own advice ? ' I reply, ' Because I know myself sufficiently to know I could make no woman happy.' "

Lady Watson (who has assisted in the compilation of this book) was a true helpmate to her husband during the 36 years of their married life. She was with him in Cairo

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and Suakim, and accompanied him in his travels all about Europe and to Palestine, South Africa and America.

Home Service (1876—1882).—On his return from Egypt (after some months sick leave) Watson was employed in the office of the Inspector General of Fortifications, Sir Lintorn Simmons, for four years. For 18 months he was Simmons's personal A.D.C. It was partly at this time that he watched over the infancy of Submarine Mines (first called "Torpedoes"), and Aviation (then called "Ballooning"). Those engaged later in such pursuits will be interested in some of the details given in the book. Writing in 1905, Watson deprecated the change of policy by which the R.E. Submarine Mining Service was suppressed and harbour defence transferred to the Navy, the idea being to use submarine vessels instead of submarine mines. Such change was, however, inevitable. The Russo-Japanese War of 1904–05 so greatly increased the importance of mines, and, in the recent war, they have been so largely (even if reluctantly) used by the supreme Sea Power, that the Army Submarine Mining Service (though excellent at the time of its suppression) was already becoming an anachronism. And now, if the ideas of President Wilson and Lord Grey prevail, the world will soon outgrow all such warlike toys.

From March 1880 till August 1882, Watson was employed in the Stores Department of the India Office.

Egypt (1882—1886).—This period includes the two most exciting episodes in Watson's life—the capture of Cairo on the night of September 14th-15th, 1882, and the Governorship of the Red Sea Littoral at Suakim from May 3rd to August 24th, 1886. For the capture of Cairo Dr. Lane-Poole has reproduced Watson's own account (published in *Blackwood's Magazine*, March, 1911), together with notes by General Lawrence who was with him at the time. By sheer bloodless bluff, Watson, with only 150 cavalry and M.I., persuaded some 6,000 Egyptian troops to march quietly out of the Citadel at Cairo, and another force out of a fort near, and to hand him over the keys. The whole account of the capture is worth reading, but the following extract gives an idea of the effective methods pursued by Watson :—

"There was a strong guard on the gate of the Citadel. I ordered the officer in charge to go to the Commandant and tell him to come to me at once. This took a considerable time, and I am inclined to think that the good Commandant had gone to bed. He came out at last, however, accompanied by a number of officers, and asked what I wanted him to do. I said that he must parade the whole garrison without any delay, and send them down to the Kasr-en-Nil Barracks in the lower part of Cairo. I said that I had brought a British force to garrison the Citadel, and that the keys of all the gates were to be handed over to me at once. He seemed a little doubtful at first, but not having any idea how many men we had, he decided to comply, and sent for the keeper of the keys, who brought a number of very large keys in a beautiful bag and handed them over. Soon bugles were heard, the troops began to hurry out of their quarters . . . fell in by companies and marched off, as if they were quite accustomed to being roused up in the middle of the night, and turned out by foreign troops."

Cairo was occupied in the morning without any fighting or riot, and the whole business was so peaceful that Watson's name was not mentioned in Sir Garnet Wolseley's despatch of the following day.

The Suakim episode is not so simple. Dr. Lane-Poole gives some data but offers no solution. The story in outline is as follows. In January, 1885, with the death of Gordon, the Khartoum relief expedition collapsed, and there was a period of confusion both in Cabinet Councils and in military plans. The scare of war with Russia (though lasting only six weeks, from March 15th to the end of April), was the conjurer's cap enabling the Government to drop the Soudan. In military matters, Wolseley's failure on the Nile naturally revived the alternative scheme of a Suakim Berber railway. This gave special importance to Suakim, which became

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the residence of four successive Governors of the Red Sea Littoral—Chermside, Warren, Watson, Kitchener. Owing to unemployed riots in London, and the demand for a "strong man" as Chief Commissioner of Police, Sir Charles Warren was removed from Suakim in the middle of March, 1886. Watson was offered the post and consented, on the understanding that he should be given military as well as civil authority. That understanding became in some way modified, and Watson had to resign, leaving Suakim on the 24th of August, 1886. During his few months rule he seems to have done a good deal, by diplomacy rather than by arms, towards pacifying the wild tribes round Suakim and reducing the influence of their chief, Osman Digna. Watson complained of the way in which he had been treated but could get no redress or even explanation. In England he was given sympathy and the C.M.G., but told not to bother. Kitchener, his successor, was at any rate not concerned in the intrigue, if intrigue there was. In the 10th August, 1886, he wrote from London to Watson, explaining that he would never have accepted had his refusal been of any use to Watson, but that he had found out that, if he refused, an R.A. officer would be appointed.

In 1889 there was an echo of the controversy, owing to a despatch from Sir F. Grenfell to Sir E. Baring, in which it was said that Major Watson had been recalled "not from political, but from military reasons." Watson (in a natural, but rather un-Gordon-like spirit) condescended to notice this remark, and was finally silenced with the formula, "that nothing has occurred in Major Watson's military career which will injuriously affect his prospects of future advancement in the service."

The personal aspects of the episode are, of course, transient, but the account in the book gives the idea that the treatment of Watson was part of a policy disapproving the conciliatory attitude towards the natives pursued by both Warren and Watson. Twelve years elapsed before the Soudan had peace. Would not that time have been shortened if the Warren-Watson policy had been continued? This point has historic interest, and, when all personal feelings have passed away, when portfolios and pigeon-holes reveal their secrets, some future historian may perhaps unravel the tangle.

Home Service (1887—1902).—On returning home, Watson was employed at Chatham for three years. For the rest of his active service (over twelve years) he was employed at the War Office, in charge of the construction of Barracks. On the 20th March, 1902, he was placed on the retired list, and in the same year was made a C.B. Imaginative gifts (perhaps unfortunately) are not usually associated with Barrack work, but one suggestion of Watson's is an exception. It was that "Barracks should be made of indiarubber and mounted on wheels, so that they could be enlarged or reduced and shifted from place to place in accordance with the changes of Army Policy."

Retired Work (1902—1916).—In 1903–05, Watson was British Commissioner for the International Exhibition at St. Louis. This meant three trips to America and residence there for over a year. His work was very successful, and he was made a K.C.M.G. He was British representative at three International Navigation Congresses, 1902 Düsseldorf, 1905 Milan, and 1908 Petrograd. He attended the British Association meetings 1909 at Winnipeg as Vice-President of the Engineering Section, and 1912 at Dundee as President of the Geographical Section. He wrote the *Life of Sir Charles Wilson*, 1909, the *Story of Jerusalem*, 1912, *Fifty Years Work in the Holy Land*, and Volume III., *History of the Corps*, both in 1915. In 1909 he wrote two pamphlets, one in favour of Universal Service, the other against the Decimal System.

But his largest and most important work after his retirement was as Chairman of the Palestine Exploration Fund for over ten years, from 1905 till his death. He lectured continually for the Fund (and he was a perfect lecturer). He contributed scholarly articles to the *Quarterly Statement*. He wrote the books above mentioned on Jerusalem, and on the work of the Fund. The book on Jerusalem is a masterpiece

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of condensed history, and should be carried in the wallet of every English-reading pilgrim to the Holy Land. He visited Palestine several times, and was Chairman of the British Opthalmic Hospital at Jerusalem. He gave much time and attention to the financial and other business of the Fund. In one of his last articles, written during the dark days of the war, he made the interesting prediction that, judging from past history, Palestine would remain under the influence of the rulers of Egypt.

Looking back over Watson's career, any one might wonder that his high character and great natural abilities did not attain wider distinction, and might be inclined to blame providence for the chapters of accidents which interrupted the continuity of his efforts. Might he not, as a student, have become one of the world's leading Orientalists? Had he not gifts for the highest rank in diplomacy? He chose to be a soldier, and his capture of Cairo certainly justified his choice, but no further opportunity came, and the rest of his military service was mainly administrative. His work for the Palestine Fund was very good, but in a different line from any of his previous energies.

Such questions are often asked about distinguished men whose friends think their distinction should have been greater. The best answer is to study the lives of the great men in history. How rarely arises a man like Nelson, really great and really loved, radiating both power and affection over his "band of brothers." Wellington, on the other hand, though his military genius shines more brightly than ever, seems to have been most unattractive, almost disagreeable, as an individual. Among the 19th Century statesmen there are Gladstone, without humour, and Disraeli, without principle (both defects most serious); among Churchmen, Newman, full of subtlety, Manning, of ambition, and so on.

After inquiring into the characteristics of great men, the student will not be too critical but only too thankful, whenever providence gives us such a thoroughly lovable, first-class, good-all-round man as Watson Pasha.

PUBLISHED WORKS BY THE LATE SIR CHARLES WATSON.

Date	Description.	Publication.
1877	White Nile Survey in 1874	Royal Geographical Society.
1878	Vocabulary—English Arabic	War Office
1880	Gordon and Abyssinia	R.E. Journal.
1886	Mosque of Sultan Nasir at Cairo	Royal Asiatic Society.
1887	Sudan—Trade Prospects	Manchester Geographical Society.
1888	Vocabulary—Suakim languages	S.P.C.K.
,,	Campaign of Gordon's Steamers	R.E. Journal.
1890	Balloons—Tables for Calculations	R.E. Institute, Chatham.
,,	Berlin—Artillery and Engineer School	R.E. Journal.
1892	How Gordon was lost	R.E. Journal.
1893	Captain Jopp, R.E., Memoir	R.E. Journal.
1894	Sudan—Suakim-Berber Route	Manchester Geographical Society.
1895	River Jordan—Stoppage, A.D. 1267	Palestine Fund.
1896	Jerusalem—Site of Temple	Palestine Fund.
1897	Length of Jewish Cubit	Palestine Fund.
1898	Jewish Measurments of Capacity	Palestine Fund.
1900	Coffer of the Great Pyramid	Palestine Fund.
1901	Second Rotation of the Earth	R.E. Journal.
1902	Construction of Great Pyramid	Palestine Fund.
1903	Great Pyramid and British land measures	R.E. Journal.
,,	Sir Lintorn Simmons, Memoir	R.E. Journal.
,,	Jerusalem—Basilica of St. Mary	Palestine Fund.
1906	Metric System	Society of Arts.
,,	Jerusalem—The Akra	Palestine Fund.
,,	Date of the Crucifixion	Palestine Fund.
1907	Jerusalem—The Akra	Palestine Fund.
,,	Sir John Ardagh, Memoir	R.E. Journal.
,,	Barrack Policy	R.E. Journal.
1908	Decimal Money	Society of Arts.
,,	Lord Cromer and Sir Charles Wilson	R.E. Journal.
,,	Division of the Circle	British Weights and Measures Assoc. Journal.
,,	Justice to Gordon	National Review.
1909	Life of Sir Charles Wilson	Murray.
,,	Universal Service	Rees.
1910	British Weights and Measures	Murray.
,,	Jerusalem—Altar of Burnt Sacrifice	Palestine Fund.
,,	Jerusalem—Traditional Sites on Sion	Palestine Fund.
,,	Colonel Conder, R.E., Memoir	Palestine Fund.

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PUBLISHED WORKS BY THE LATE SIR CHARLES WATSON—(*continued*).

Date.	Description.	Publication.
1910	Colonel Conder, R.E., Memoir	... R E. Journal.
,,	Gordon, Memoir	... Encyclopædia Britannica.
,,	Jerusalem	... Encyclopædia Britannica.
,,	The Holy Sepulchre	... Encyclopædia Britannica.
1911	Weights and Measures	... Whittaker's Almanac.
,,	Cavalry March to Cairo	... Blackwood.
1912	Jerusalem, The Story of	... Dent.
,,	British Weights and Measures historically considered.	British Weights and Measures Assoc. Journal.
,,	Commematorium de Casis Dei	... Palestine Fund.
1913	Colonel Archer, R E., Memoir	... R.E. Journal.
1914	The Desert of the Wanderings	... Palestine Fund.
1915	Sir H. Prendergast, Review of Life	... R.E. Journal.
,,	Babylonian Measures of Length	... Biblical Archæology Society.
,,	Egypt and Palestine	... Cornhill.
,,	History of Royal Engineers, Vol. III.	... R.E. Institute, Chatham.
,,	Fifty Years Work in the Holy Land	... Palestine Fund.

NOTE.—Dr. Lane-Poole (who was an old friend of Watson) explains in the preface that owing to ill-health he was unable to complete the book himself. His assistant, Mr. Skeat, is a son of the late Profesor Skeat, and was for many years in the Civil Service of the Malay Federated States. By a misprint on the title page of the book he is described as of the Indian Civil Service.

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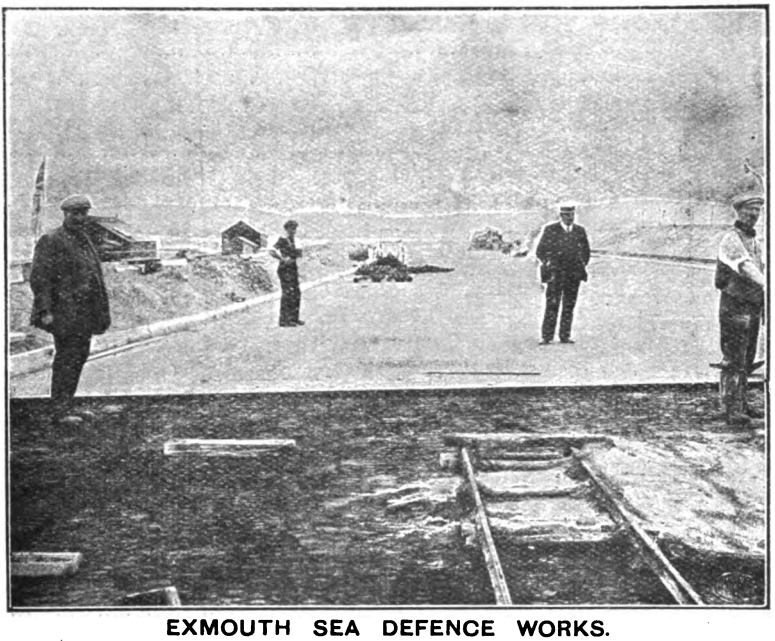

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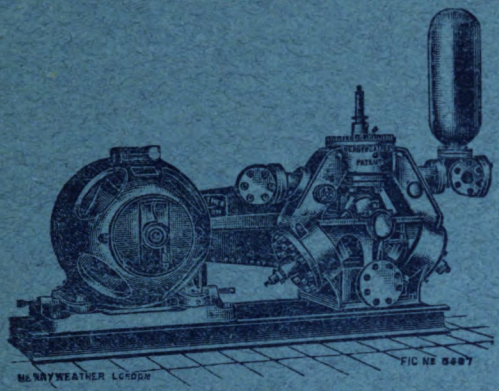

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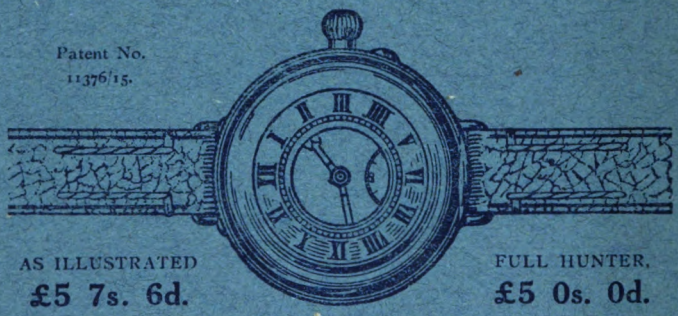

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PROPAGANDA BY BALLOON.

By CAPT. L. C. PITMAN, R.E.

A CERTAIN amount of publicity has recently been given to the subject of Propaganda by Balloon, and as it is one of the many new methods of warfare in which the Corps has been called upon to assist, a few particulars may be of interest to R.E. officers in general.

Early in the war leaflets had been distributed to the enemy by dropping them from aeroplanes. At the beginning of 1918, however, it was decided to adopt other methods for the distribution of propaganda. This decision was taken partly on account of the desirability of vastly increasing the distribution of propaganda, as at that time the supply of machines and airmen was barely sufficient for the primary functions of the aerial forces, and partly on account of the reprisals taken by the Germans upon airmen captured with propaganda on their machines.

Accordingly many experiments were carried out by various departments, and eventually a small paper balloon with an automatic release was adopted as the best method for the future distribution of propaganda. In March, 1918, the Royal Engineers took up the supervision of the manufacture of these balloons and releases, and also carried out the loading of the releases with propaganda, the balloons and loaded releases being despatched to France two or three times a week (a staff of nearly 100 girls was specially employed on this work). During the period March, 1918, to the signing of the Armistice, over 35,000 balloons and 20 million leaflets attached to releases were despatched to France.

This method of educating the German troops soon began to bear fruit, as evidenced in the numerous caustic extracts published in the German papers from time to time, and culminating in the manifesto issued by Hindenburg early in September, in which he bitterly complained of our method of bombarding his front, not only with a drum-fire of artillery, but also with a drum-fire of printed paper.

The Germans did their utmost to prevent the circulation of the leaflets, and as much as five marks was offered for each leaflet brought to Headquarters, but many German prisoners were captured with leaflets in their possession, which they displayed to their captors, doubtless hoping for preferential treatment thereby.

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Consequently there is thought to be little doubt as to the great success of the propaganda generally.

I. BALLOONS.—In their original design a capacity of 95—100 cubic ft. was aimed at. It was thought that a paper balloon of this size would be large enough for convenient handling and filling. Moreover, it was hoped that the weight of such a balloon could be kept down to approximately 1 lb., thereby leaving a surplus theoretical lift of 5½ lbs. for the balloon when filled with hydrogen. The balloon as originally designed was far from perfect, and in the course of manufacture many improvements were introduced. The balloon, as finally adopted, was pear-shaped, made up of "doped" paper cut in 10 longitudinal panels, joined at the top by a circular paper crown of double thickness and at the base by an oiled silk neck about 12 in. long by 3 in. diameter for filling purposes.

The dimensions of the balloon were as follows :—

Length uninflated	...	...	9 ft.
Length inflated ...	...	...	8 ft. 3 in.
Maximum circumference		...	18 ft.
Weight (approx.)	...	...	1 lb.
Cubic capacity ...	...	...	95-100 cubic ft.
Initial surplus lift	...	...	5-6 lbs.

In designing such a balloon the following points required very careful attention :—

(*a*). The quality of the paper used.
(*b*). The composition of the "dope" used for making the paper gas tight.
(*c*). The composition of the gum or paste used for jointing the panels of the balloon.

(*a*). *Paper*.—The paper had to be exceptionally strong and tough to withstand the amount of handling required both during manufacture into balloons and also during the process of inflation at the front. At the same time the paper had to be light in order to keep the weight of the balloon as low as possible. It was not easy to obtain a paper satisfactorily fulfilling both these conditions, after many trials the best results were obtained from paper made of the best white rags, as used for bank paper, and all such paper had to withstand a test of at least 26 lbs. bursting pressure per square inch before being "doped."

(*b*). "*Dope*."—Paper, not being hydrogen or gas proof, had to be given two coats of "dope" before being made up into balloons. The composition of this "dope," which was and still is a trade secret, was only arrived at after many trials and failures. A number of "dopes" were found, on trial, to make the paper sufficiently gas proof, but at the same time, to so greatly increase the weight of the

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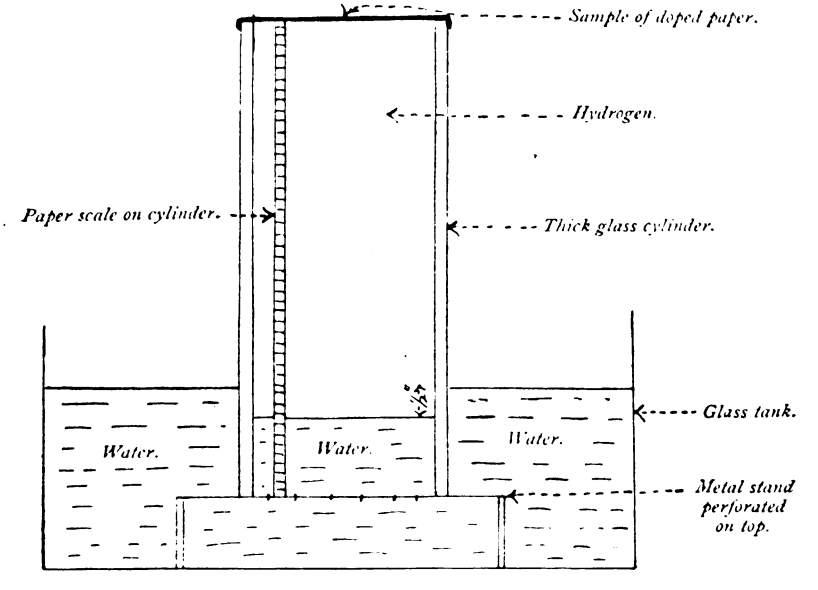
paper that they had to be discarded, whilst others, which kept within the limits as regards weight, failed to make the paper gas proof. One excellent "dope," fulfilling both conditions, had to be discarded owing to the difficulty in obtaining one of its ingredients in sufficient quantity (the available quantity being required for aeroplane wings). However, a "dope" was finally adopted which, while keeping within the limits as regards weight, made the balloons sufficiently gas proof for the first few hours after inflation (see tests below).

(*c*). *Gum.*—The composition of the gum depended directly upon the nature of the "dope" used. Ordinary paste or gum was found to give no permanent adhesion with doped paper. The paste at first used appeared to be satisfactory when the balloon was completed, yet on unpacking in France the joints opened out at once. After many tests a suitable paste was evolved, the composition of which also remains a trade secret.

TESTS. (1). *Bursting Pressure of the "undoped" paper.*—Samples of the "undoped" paper were taken from every consignment as received from the paper mills, and were tested for bursting strength in a small Ashcroft Paper Tester. Any paper unable to stand 26 lbs. per square inch was rejected. It was found that the paper, after "doping," increased in strength by about 5 lbs. per square inch.

(2). *Laboratory Test of "doped" paper for gas tightness.*—Samples of the "doped" paper from each consignment were subjected to this test as follows :—



A thick glass cylinder about 7 in. long and 4 in. diameter, open at each end, was taken and thoroughly cleaned, special care being

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taken to see that the top end of the cylinder was perfectly even and smooth. The sample to be tested was then well cemented down, with the paste used for the panels, over the top of the cylinder. After resting three or four hours to allow the cement to set, the cylinder was placed upon a perforated metal stand resting in the bottom of a glass tank of water. The air was then extracted from the cylinder by means of an exhaust pump and tube, the water rising in the cylinder until it reached the top. Hydrogen was then passed into the cylinder until the water fell to about $\frac{1}{2}$ in. below the water in the tank, thus subjecting the hydrogen to about $\frac{1}{2}$ in. of water pressure. The height of water in the cylinder was accurately read by means of a scale of inches fixed to the cylinder. After a period of about 20 hours, if the rise of water did not exceed $\frac{1}{4}$ in. the paper was considered sufficiently gas tight.

(3). TEST OF BALLOONS FOR SURPLUS LIFT.—The apparatus used for this test was very simple, and consisted of an accurate spring balance mounted vertically and connected by a wire to the balloon with two ordinary bicycle wheels (minus tryes) for changing the direction of the pull with a minimum of friction.

Balloons were taken out of supply from time to time, filled with hydrogen, and attached to the apparatus. The initial surplus lift was recorded and further readings were taken at known intervals, the results afterwards being plotted in the form of a graph. The accompanying graph shows the surplus lift for five balloons lettered A—E, during a period of 24 hours after filling. Out of this batch of five it will be seen that Balloon A was the most perfect, and gave the best results. As, however, the longest release used only had a maximum run of three hours, and a total initial weight of 4 lbs. 3 ozs., continually decreasing throughout the run as the pamphlets were dropped, all these five balloons would therefore have been considered satisfactory.

(4). MECHANICAL TESTS.—In addition to the above three general tests, every individual balloon was subjected to the most careful examination for mechanical defects such as small holes or flaws in the paper, seams or joints insufficiently pasted or gummed, etc.

II. RELEASES.—The release or automatic arrangement for carrying and dropping the leaflets was of very simple construction. It consisted of a short length of thick cotton tinder wick $\frac{5}{8}$ in. diameter, similar to that used for many pipe and cigarette lighters, and having a rate of burning of five minutes to the inch. The wick was threaded upon 20-gauge iron wire, looped through it at intervals, the top 6 ins. of the wick being left free of the wire. The wire extended another 6—9 ins. above the wick, by which extension the release was fastened to the oiled silk neck of the balloon. Tags, India 4-in. or 5-in., as used for fastening official correspondence, and issued by the Stationery Office, were passed through the wired portion of the

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wick at ½ in. intervals as a rule, and either ¼ or ½ lb. packets of leaflets were threaded upon each tag—the result being that on lighting the wick at the top, it slowly burned downwards, and on reaching each tag in turn burnt through the string and released a packet of leaflets.

Four or five types of releases were standardized, differing only in respect of the length of the tinder wick and the spacing of the tags for holding the packets of leaflets. The type most frequently supplied was designed for use with balloons, liberated a few miles behind our front lines, for dropping leaflets over the enemy's front lines to a distance of a few miles behind them. The length of the tinder wick in this type was 12½ in.

The upper 6 in. of the wick, being free from the iron wire, could be cut, before lighting, to the necessary length in accordance with the strength of the wind and the distance of the despatching station from the enemy's front line, remembering that an inch of wick burns in five minutes. The lower 6 in. had bundles of leaflets attached to the tags at ½-in. intervals, whereby a bundle of leaflets was dropped every 2½ minutes after the balloon crossed the line. Similar but longer releases with tags at greater intervals were used for long distance work.

The total weight of leaflets put on any release was approximately 4 lbs., whilst the empty releases weighed from 1—3 ozs., consequently the total weight put on a balloon never exceeded 4 lbs. 3 ozs. The longest release made was 40 in., representing about three hours run.

III. LEAFLETS.—The leaflets were printed on single or double sheets of various sizes, and were all punched with a ¼-in. hole in one corner to enable them to be threaded upon the tags, and were left unfolded. Amongst the numerous subjects dealt with were the following :—

(*a*). *Le Courrier de l'Air.*—A weekly paper printed in French, containing the latest official communiques and war news from all fronts, together with various extracts from the Allied, Neutral and Enemy press. The paper was for the benefit of the inhabitants of the occupied area of France and Belguim.

(*b*). Extracts from suppressed editions of German pamphlets or newspapers.

(*c*). Speeches made by prominent Allied Ministers from time to time.

(*d*) Photographic facsimiles of suitable letters written by German prisoners of war to their relatives.

(*e*). Picture post-cards of Prisoners of War Camps, illustrating the conditions and comforts under which they lived.

(*f*). Statements giving the numbers of the American Army arriving in France from time to time.

(*g*). Lists of the German submarines sunk or captured, with the names of their commanders.

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(*h*). Comic cartoons depicting the conditions under which the German people lived.

(*i*). Small maps with descriptions showing the advances made by the Allied Armies from time to time in the great offensive.

Despatch.—The paper balloons, folded flat and packed about 80 in a case, and the loaded releases packed 20 in a case, carefully labelled, showing contents, were despatched from London three times a week by passenger train. Lorries met these on arrival at the French port and conveyed them to G.H.Q., whence they were despatched to the various releasing stations behind the lines. The system was so organized that any propaganda could be composed, printed, loaded on releases in London and despatched over the German lines within three days.

The procedure at the releasing stations was simple. A balloon was laid out flat on the ground in a sheltered position and filled rapidly from hydrogen cylinders. A loaded release was taken, the free end of the wick being cut to desired length in accordance with instructions issued, which instructions were based on the strength of wind and distance from the German lines, and attached to the oiled silk neck of the balloon by means of the free end of wire. The top of the tinder wick was then lighted by a match or a lighted cigarette, and at the last moment before the balloon was liberated a small vertical cut was made in the oil silk neck above the fastening to enable the gas to escape on expansion. As many as 400 balloons, each carrying 500—1,500 leaflets, have been sent over the lines in one day.

CONCLUSION—It will be noticed from the graph that the initial surplus lift of the balloons was from 5 to 6 lbs., and the weight of the loaded releases being approximately 4 lbs., left a balance of 1 to 2 lbs. remaining, which carried the balloon to 4,000—5,000 ft. Owing to the expansion of the hydrogen, and consequent loss of gas through the slit in the neck of the balloon, the lift rapidly became a negative quantity, apart from the small gradual reduction of lift due to loss of gas through the paper. This effect was soon counteracted by the release which began to drop its $\frac{1}{4}$ or $\frac{1}{2}$ lb. packets of leaflets at $2\frac{1}{2}$ minutes intervals, and consequently the load on the balloon rapidly decreased and caused it to continue its flight long after the release was burnt out, and all its pamphlets dropped. It is known that balloons did come down in distant parts of Holland and far into the interior of Germany.

A sample balloon and release, together with a file containing a copy of each of the various leaflets distributed, have been presented to the R.E. Museum at Chatham.

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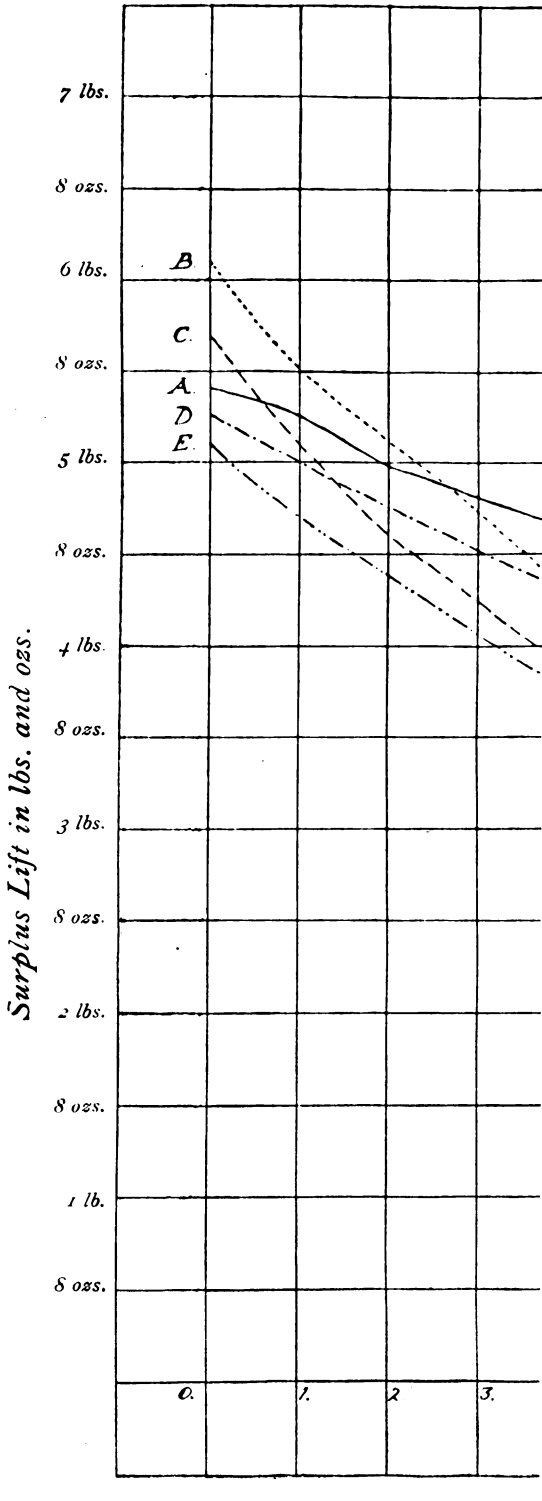

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INSTRUCTION IN THE PRINCIPLES OF THE ORGANIZATION OF GROUND IN DEFENCE BY MEANS OF MODELS.

By MAJOR F. D. NAPIER-CLAVERING, M.C., R.E. (S.R.).

IT is intended in this paper to indicate a method of teaching R.E officers the principles of the organization of ground in defence by means of models.

It is contended that the model system would produce better results than the present method. The model system trains the mind by eye and ear simultaneously. The present method attempts to do so, also relying on lectures with maps for the inculcation of the principles. Now the art of reading a map is an extraordinarily difficult one, and experience of this war shows that there is hardly anyone who can readily visualize the ground from an ordinary contoured map. This has been realized and layered maps have been introduced, but when an operation is intended, and there is time to do it, the best troops supplement the map by having a large model constructed of the ground in question and make all dispositions from this model. Officers are also taught what the map means from this model.

To the vast majority of junior officers, who have not had extensive practice in reading maps, the map does not express the shape of the ground sufficiently vividly to be useful when discussing the organization of it for defence. They need the third dimension actually visible, not conventionally represented as it is on the map. It is useless therefore for an Instructor, when considering some problem, say, the siting of a trench, to draw contours on a blackboard to illustrate his point. The student perhaps sees dimly what he is driving at at the time but he will not recognize it on the ground. Officers taught in this way learn very little from the instruction; nearly all is learnt on the ground itself. During the war the theory of the organization of ground has gradually dawned on the regimental officer through constant practice of the application. Any instruction he received was found of little value because of the gap between the lectures with maps and the schemes on the ground. Models will bridge this gap.

Models are like pictures in that they can be committed to memory quite easily by everybody who looks at them carefully. It is extraordinary how they impress themselves on the mind. They create a vivid mind picture which can be called up whenever it is required.

The equipment of a lecture room with models for the principles

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of the organization of ground in defence would be bulky and probably costly. The result, however, is that every honest student would be provided with a set of mind pictures of the principles with which he can compare his actual problem on the ground. This is far better than leaving knowledge to dawn on the officer through years of trial and error. The years will chiefly be filled with error. In addition to this the pace of this gradual dawning of knowledge depends on the mental equipment of the subject, and leads as a study of trench maps shows to a very great variety in the quality of work done. The fact is that, even after the last four years, the average R.E. officer has a very hazy idea indeed of what the principles of the organization of ground in defence really are.

These principles are bound up with the *shape* of the ground and it is only by considering various shapes of ground that the principles can be thought out and taught. This can be done slowly on the ground itself, but far better by models of battlefields which have actually been fought over for the following reasons :—

The great drawbacks to a tactical scheme on the ground, as carried out at present, are threefold.

In the first place the mind cannot get an exact impression of the ground owing to its size ; secondly, the situation is imaginary and therefore to a certain degree unconvincing ; and thirdly, it takes time to do any one scheme. To the student of war each scheme is a problem unconnected with any other ideas. It is interesting provided the weather is good and there is time to come to a considered solution. All the principles which may be stated in words are, however, clouded by the excess of detail on the ground itself and seem to be warring one against the other. The whole thing appears to be an unsatisfactory compromise and is often unconvincing.

This impression arises because the principles are not grasped initially. A tactical scheme should be an illustration of principles applied to ground. But it cannot be an example if the principles are not first of all firmly imprinted on the mind. I hope to indicate how this grasp of principles can be got by means of models in the lecture room before the student is allowed to do a scheme outside.

One criticism of the model system is that it undermines the idea that map reading is one of the first duties of an officer. Suppose this to be the case it is of little importance for it must be admitted that the standard of map reading among regimental officers (even for the purpose of the location of points, let alone the reading of the shape of the ground) is far from good, However, there is no fear of the importance of map reading being lost ; in fact if maps of the models are provided the art can be practised very efficiently from them.

It is not proposed in this paper to enunciate the principles which should be imprinted on the mind of the young officers. But by way of example the accepted principles laid down for the siting of

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defensive systems in France in 1918 have been taken, and the following paragraphs show how these principles may be taught by models.

The principle of Artillery observation.—"Artillery observation of the ground for at least 400 yards in front of the line of resistance is essential." This can be maintained by O.Ps. behind or on the flanks. If this is not possible the M.L.R. must be pushed forward to cover an O.P. In the first case a reverse slope infantry position is possible and often desirable. In the second a forward slope position is probably obligatory. Now nearly every trench map of a part of the line in France contains a solution of some kind of this principle on the ground, and it should be possible to find an actual example which would combine a fair number of typical situations in one area of moderate size. If a model of this was produced to a suitable scale and the instruction carefully given, every student should be able to get in his head a mind picture of the principle which would be of vital use when organizing ground for defence.

The principle of Localities.—"Important tactical features should be decided on first and treated as localities, the lines connecting these are altogether subservient." This is another principle which is, to some extent, difficult for the inexperienced to grasp and which could be easily taught in the same way.

Woods and Villages.—The way to deal with these would be to have a movable wood or village placed on the model at various points and discuss what modification of the line is necessary in each situation.

The principle of the M.G. Framework.—"The R.A. officer marks on a $\frac{1}{40000}$ map the positions necessary for O.Ps.——; and the M.G. Officer marks M.G. positions for defence of the line in depth on a similar map."

"The necessary information for getting out the final siting of the trenches is now available. The final siting will be a compromise between the R.A., M.G., and Infantry points of view."

The models for teaching the principles of this final siting should be on the lines of the attached map. The idea that the trench plan must be subordinated to the M.G. plan could be shown by contrivances such as miniature searchlights at the M.G. positions throwing beams along the lines of fire; or wires along the lines of fire made incandescent by an electric current. In the same way when the M.G. plan has been demonstrated, the trench system formed in the model of some transparent material could be shown up at will by switching on a light under the model. The ocular effect so produced would be far more convincing than for instance, the study of the attached map.

The principle of mutual enfilade fire.—"Trenches should be sited in general conformation to the contours so as to give mutual enfilade fire. This ensures converging fire being brought to bear on valleys which are the mostly likely avenues of attack and penetration."

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"The general alignment of trenches will therefore be very irregular following the lie of the ground——running forward on spurs and back in valleys."

This principle is elemental and is not apparently sufficiently widely known by officers siting trenches. Even excepting front lines, the more one studies trench maps of the British lines the more one is forced to this conclusion. Here again the fault can be minimised by instruction by model.

Standard examples such as the following if firmly held as a mind picture would go a long way towards helping the siting officer to avoid violating this elementary principle.

1. A forward slope position with a knoll in or near the line.
2. A forward slope position with a valley perpendicular to the line.
3. A similar position with a valley running into it diagonally. This raises the question of holding the ensuing spur.
4, 5, and 6. The same problems in a reverse slope position.
7. Rolling fields parallel to the position.
8. Rolling fields vertical to the position, etc., etc.

In all these situations it is of course necessary to consider the problem with reference to the positions occupied by the automatic arms.

Summary.—Sufficient examples have now been given, it is thought, to outline this method of modern instruction.

The number of models used should be large enough to embrace all types of situations likely to be met in the field but not too numerous, or they will be forgotten. If the right number is chosen the student tackling a problem on the ground will start thinking on these lines. "This ground is different to any of the models but it reminds me of this one rather than that. Now, how did the problem work out on 'this' model."

The original contention was that the present method of teaching can be improved. The art of education is developing at a high rate, and in order to bring this form of instruction up to present day standards it is necessary to consider the problem from the point of view of the individual being instructed. This study leads to the conclusion that, at present, the majority of students of the art of defences are unconvinced by their instruction. Models used by a skilled and imaginative instructor will provide a firm grasp of principles in even the sub-average mind. The standard of execution of work will improve in proportion to the extent to which the method indicated is more convincing than the old method of lectures and maps.

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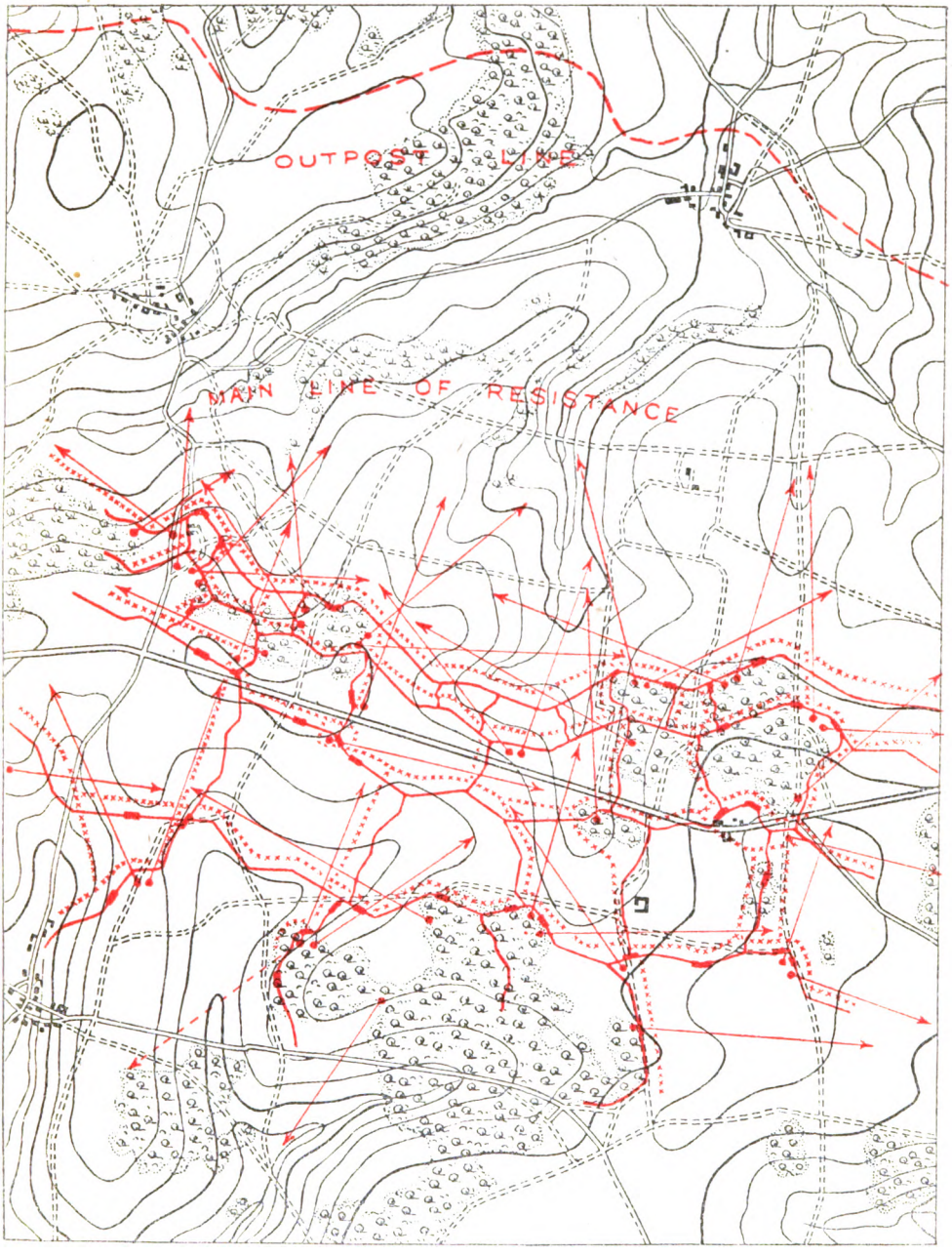

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FROM THE CURRAGH TO THE AISNE, 1914.

A STORY OF THE 59TH FIELD COMPANY, R.E.

By BRIG.-GENERAL G. WALKER, D.S.C., R.E.

THE following was written as a Lecture to Cadets of the Corps :—

The order to mobilize came on the afternoon of the 4th August. We were all sitting at tea and it was a lovely evening, when two of the subalterns poked their heads in at the drawing room window and announced that "it" had come, "it" being the telegraphic order to mobilize. We had all been hourly expecting the order, yet it came in the end as rather a shock. Some of the older ones amongst us I think realized what it meant—but the young people were exuberant with joy. I remember going into the Mess a few days before and finding two of my subalterns reading the morning paper, and, on my asking what is the news, one of them replied rather disconsolately: "I believe the blighters will wriggle out of it after all." That was their only fear. Well, the blow had fallen at last, and the comparative peace of an annual course of musketry was turned into the turmoil of preparations for War.

Fortunately the whole thing had been worked out very carefully in detail during the previous winter. Everyone knew what he had to do and when he had to do it. The sections including reservists had been told off, time tables made, and the Company daily orders consisted of only one sentence: "Detail for to-morrow as such and such a day of Mobilization, see Mobilization Scheme." Everything worked like a clock. We got all our stores with a few unimportant exceptions, and there was no fuss or worry.

The only trouble that I remember was that the mobilization horses insisted on succumbing to strangles as they came in—the disease being prevalent in the country at the time. The first time the Company was assembled on parade it made a brave show, the only anxiety I had was that 75 per cent. of the men and horses were reservists or newly off farms—and consequently soft. I believe the whole of our Division was the same, so in no sense could it be said to have been completely trained. The reservists were put through a short course of musketry, and some of them told me they had not held a rifle in their hands for eight years. We had, however, our trained N.C.Os., and they pulled us through. I would like to say a word about some of the details of organization which we found later were important, especially in moving warfare.

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First that each section of the Company was organized as a self-contained unit—it always carried its food in its own carts. Secondly each section had its own farrier, or a smith who could shoe a horse, wheeler, collar-maker, and cooks. These last had been a special fad of mine in peace time, and I had been able to get several men through the Aldershot School. By each section I mean all the five, viz., H.Q. and the four fighting sections. The result was that the subalterns were able to carry on alone, and the men were always well fed.

Journey to France.—We left the Curragh by train for Dublin on the 16th August, our horses and wagons marched up 33 miles the day before, and by 7 p.m. on the 16th, which was a Sunday, we were all embarked, and sailed that night, arriving at Havre on the 18th. Our only excitement was being held up and boarded by a French destroyer off the Channel Islands. It was rather an amusing scene. We were all asleep about midnight, I was in pyjamas in the Skipper's bunk when the alarm sounded, the O.C. troops was a Gunner and he and his Adjutant were trying to make up their minds which of the many secret papers should be burnt. The question was settled by myself and the Adjutant burning the lot in the galley fire. Then a French Naval officer came on board. Such was the relief of the Skipper and our O.C. that they got angry and refused to show him anything unless he produced his credentials, which seemed to me, at least, to be sufficiently substantiated by the destroyer, its searchlights, and its guns. However, all was well in the end, and our Naval friend was consoled with a drink—and so to bed again.

At Havre we disembarked, and I can remember little there except that the sailors dropped one of my loaded pontoon wagons "complete" into the hold and smashed it to atoms, and that I stole a day's rations for the company from the A.S.C., which were most useful later on in the great retreat. We were two nights at Havre in a dirty, wet rest camp, and then proceeded up country by rail. We left at 1 p.m. on the 20th, and had an uncomfortable journey *viâ* Amiens and Le Cateau to Landrecies.

The March to Mons.—We detrained at Landrecies at 4 a.m. on the 21st August, and here at last we took to our feet. It was a lovely morning. We fed ourselves first thing while I looked for orders. However, there were none and no staff about. The Division I was told had gone on towards Bavai, and a staff officer whom I met could only suggest my following. There was no news of Germans, and nothing to guide us as to what was the military situation. However off we started. It was piping hot and very thirsty work. The poor old reservists were soon dying with thirst, their water bottles were soon emptied, and then they took to raw fruit, apples, pears, plums, etc., which were freely dispensed by the

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country folk, but at last I had to stop the fruit. The road was littered with stragglers of the Division, and we had a lot of chasing to do to try and get them on. We were all decorated with flowers. I know I had two bunches of roses on my wallets and roses stuck behind my horse's ears. Every one was full of hope—soldiers and country people. We had a good billet at Bavai, plenty of food and wine and a good bed, and then on next day, the 22nd, over the Belgian Frontier through Dour and Elouges to the Mons Canal near Thuin. We got in about 3 p.m., and were ordered to put the bridge heads into a state of defence. No one was told what was happening, but we set to work to help the Infantry.

There was no warning to us of anything serious coming, and so far we had not seen a German or heard a shot fired.

Mons.—Next morning, the 23rd, the fun began. Bridges to be destroyed was the order, and we set to work to prepare. I think we had three to do. However, I was sent back to reconnoitre a second line, and did not meet the company again until midnight that night, when they marched into Dour. They had got their bridges down and had not had many casualties, although the Germans were close up with field guns before the charges were fired. One exploder was actually knocked to pieces by a 77 mm. shell at Thuin, and the men were hit by the flying fragments of the iron bridge.

Though all our demolitions were successful it did not stop the Germans long. The canal was narrow and they soon bridged it with pontoons. We lost our last pontoon this day. It had been used to make a bridge over a small stream near the canal to help the infantry, and had to be blown up to prevent it falling into the hands of the Germans. I did not hear the last of this for a long time, and came to the conclusion that some people would have preferred to lose a lot of men as well as the material.

It was a horrid night, no sleep for me and many more, though the men got some. Infantry and Artillery retiring to the position I had been reconnoitring, all with the same tale of casualties and overwhelming odds, lots of friends gone, but still there was no sign of panic or fear. Next morning, 24th, we were out at work on the new position at cock-crow—we were on the left of the line. Personally I was on the extreme left with my junior subaltern Carr, who had only six months' service. His section and an infantry battalion were preparing a farm place for defence. The work went on quite quietly. We were not fired at, and had a grand view of the German flank movement. They were trying to get round our left and we could see them in action against a British Cavalry Brigade that were covering us in that direction. Quite an exciting show to see a real cavalry charge, and still no bullets or shells. They were trying to lull us into a sense of security, but they were disappointed.

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At 11 a.m. came the order to withdraw, and away we went quite quietly and orderly. I met my other sections by Dour Church, and we marched slowly back through the narrow streets of that squalid little mining town. It was a tedious business, and we were not clear of the place until 2 p.m., but we were never shelled. I found afterwards that the fighting was mostly on the right of the 2nd Corps, or on their left rear, so that we in the left centre had a quiet time.

When we got clear of the town on the Bavai road we could hear a furious battle in the direction of Elouges. This was the 2nd Cavalry Brigade covering the left flank. They were being supported by infantry and guns from the Division and I got an order to escort some guns. Luckily the Cheshires arrived in time to relieve me, and I pursued my way to my ordered halting place for the night. One curious point cropped up in connection with this, as no route was given to me I was told to do what I liked, I went *viâ* Bavai and found later if I had gone the other way I should have been caught by German Cavalry. I got to Bavai all right, passing en route the remnants of the 2nd Cavalry Brigade returning from their fight. At Bavai I found the H.Q. of the 2nd Corps, the British G.H.Q., and the 3rd Division, which had been on our right at Mons, marching through. We spent the night sleeping on the cobbled streets, and filled up our food wagons from a dump beside the road. A good supper for the officers, consisting of omelette and beer, in a café. I found the Divisional H.Q. late that night but no orders, and we were roused from stony couches at 3 a.m., and told to march at once (25th). The night was quiet, only a few outpost affairs, but we got no shells, and we started off and took the road for Le Cateau. It was a long 12 hour march and very hot, but we did it all right and got a nice bivouac in an orchard at Roumont, just behind what became the battlefield of Le Cateau on the morrow. It was a wet night but the rain was refreshing, though we all slept in the open.

We got our orders for a further retirement next day at 11 p.m. Next day, 26th, we sent off our baggage and what remained of our bridge equipment at 6.30 a.m., and were ready hooked in and ready to follow at 7.30, when Sir C. Fergusson, our G.O.C., came up and told us we were going to fight and not retire. Shortly afterwards the C.R.E. ordered us down to Le Cateau railway station, about four miles away, to collect stores in order to improve the trenches. I think in the light of after events that it was the old story of not knowing what to do with the R.E., they did not much know where the trenches were, and the battle had been actually started. I remember asking the C.R.E. if he knew whether Le Cateau was clear, and he was rather surprised at me for asking this question. However, I was not taking any risks, and sent my

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Captain on with all the cyclists as an advanced guard. It was lucky I did so, for when about 1½ miles from the station, I met some ammunition wagons retiring at a gallop. They ran into us and scattered us on the road. We gathered that the "Germans were coming" as we picked ourselves up, and I could see the troops retiring westwards on the heights above the town. It was a question of what to do; go on or back. I extended two sections, one on either side of the road (the country was very open and we could see well), and we moved on for a short time until I met a perspiring cyclist from my advanced guard with a note from my Captain telling me not to go on, as the Germans were in the station and had fired on him. He shortly afterwards rejoined us and we decided to move up the downs on our left (north) and try and get in touch with the infantry. We did this and hit off two Reserve Battalions of the 19th Brigade—we got our picks and shovels, sent the carts to the rear, and set to work to help entrench the two battalions. As far as I remember they had no tools except entrenching implements, and we had our work cut out for us—tools with the infantry in those days were considered trifles. They learnt wisdom later, but it took months before they did.

We laid out a line and got to work and stuck at it all day. Meanwhile the battle in front went on. It was the finest pyrotechnic display I have ever seen. The German shells were bursting all about. They came from all directions except the rear, and the bursts were of all colours, white, black and white, black and pink, and yellow. We could see but little of the infantry, but could see the yellow bursts of our Lyddite shells in the enemy's lines. It was a lovely day, brilliant sun and no wind, and a German 'plane sailed placidly to and fro over our heads directing the fire. We could see the Artillery Ammunition Columns disposed in solid squares on the reverse slopes of the ground in front, and altogether it was very like the pictures of an old-fashioned battle.

The country was a huge corn field with the corn cut and put up in stooks, and one of the saddest things I have ever seen was the wounded horses trying to keep themselves on their legs by leaning against the stooks of corn. Our casualties were *nil* so far, as the shelling did not seem to catch us, though it was unpleasantly close at times. At about noon some of the 19th Brigade made a counter-attack. I, in my enthusiasm and ignorance, thought we were going to win, and I sent back for my horses and tool carts, but alas! it was to be the other way about. Very soon the counter-attacking troops re-appeared over the ridge, and came dribbling back, many wounded, and all shaken, very few officers. I met one huge Highlander of the Argylls who said to me, "They call this war; I call it b—— murder."

Now our time came—we knew nothing officially—a staff officer

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appeared just about this time and he and I went together to emphasize the fact that there was to be no retirement. He very soon left us and he was the only staff officer I saw until 5 p.m. that night. We spent the time collecting the straggling infantry and putting them into our trenches, the sappers being evicted and made to lie in the open. It was a trying job as the infantry were shaken and we officers knew nothing. However, we were determined not to go back and we gradually steadied the men. The sappers behaved beautifully and never turned a hair, whatever they may have thought, but they had not suffered like the others. One incident at this time struck me very much. I saw a Company of infantry led by an officer deliberately rise from their trench and begin to retire. I dashed over to him and asked why. I was told by the Captain that he had had the order. On asking from whom, he replied: "From that officer there," pointing out an individual, who promptly replied: "You are a —— liar." I mention this as an instance of how such things may happen. I am pretty certain that someone who wanted to be off passed the word down to the officer, who, thinking it *bona fide*, acted on it. However, they all went back to their trenches at once.

Things were by this time looking pretty shaky and the question really presented itself of what we were all to do. As far as we knew our flanks were open; we had no orders, and we could see the German infantry coming on in large numbers. A major of the Argylls and myself sized up the situation and came to the conclusion that there were two alternatives—one to stick it out to the end, the other to remain as long as we could and then retire in order to a second position, behind us on the outskirts of the village of Roumont. The senior officer on the spot, a Lieut.-Colonel (since dead), decided on the latter, and we opened fire with our rifles at about 1,500 yards, too long a range I thought, but the firing steadied the men. We had no artillery support and the Germans were coming on, some in extended order and some in a heavy column of fours. They came pretty gingerly and the column wheeled about and retired when we opened fire, so I suppose we hit someone. I imagine that they were surprised to find any further resistance. Our fear was for our right flank, where there was a deep valley which we could only watch and as far as we knew we had no supports anywhere. As a matter of fact I heard long afterwards that this flank was covered by a whole battalion, echeloned behind us, so really we were fairly safe. I mention this to show what a fog we were in. I believe the truth to be that the staff was at this time so busy getting troops on the road that they forgot us altogether. However, we did not forget ourselves. Our Lieut.-Colonel gave the order to move back I think about 4.30. I am afraid this was not a very orderly movement. Although it was ostensibly to a second

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position it never stopped, and that was the last I, or any of us, saw of the field of Le Cateau. We got so mixed up that I shouted out "59th Company, Halt!" and the sappers stood like stones and let the others go on. We formed up in two ranks and marched solemnly off in fours and not a shot was fired at us. I personally felt pretty cheap, but when I got down to Roumont Cross Roads I met my C.R.E., who said he was very glad to see any of us alive! A staff officer then told us we had done quite right, and to get along down the road.

I must here mention a curious incident as regards my horse, a fidgety black mare I had hunted for two years before the war. I sent her back with the wagons about 8.30 a.m., and when they were sent to the rear by the staff the subaltern in charge left the mare tied to a tree, hoping I should find her. As we were leaving the field at 4.30 p.m. I saw an officer on a familiar-looking horse, and on closer inspection found that he had my mare. He was very loath to give her up. That mare has a large experience, as I eventually took her with me to Macedonia, where I had to leave her with a friend when I was invalided home. I don't suppose I shall ever see her again. So much for the narrative of what I saw.

What struck me most was the absolute lack of orders and the fog so to speak in which we acted, next, the steadiness of the men, and lastly, the way the artillery were disposed. They were shoved up so close that their ranging power seemed to be a neglected quantity. They suffered dreadfully, and one brigade that I marched with often during the retreat only had two guns left out of 18. At the end they could not get the teams up alive to take the guns away. I have said nothing of the battle generally, speaking only of what I saw, which was very little.

The Retreat.—When we got on the line of march again a dismal prospect presented itself to us. The road was lined with overturned vehicles, from motor lorries to forage carts; the troops were marching steadily and in good order, but were terribly mixed up, each unit and arm took the road in the order it appeared off the field. I had no wagons, food, or stores, but was told I would meet them down the road. We marched on slowly unmolested as we had a rear guard behind us, and eventually arrived about 9 p.m. at Estrées, where our wagons were parked in a ploughed field. I never was so glad to see anything in my life, and lay down in the pouring rain to get some sleep, as we were told we were to go on again at midnight. No fires were allowed, and we were all pretty miserable, though I heard no grousing. The Signal Company which had come in before us gave me a bit of cold chicken and some whiskey, but only a few got anything. We marched on at midnight, a horrible experience, though carried out strictly, the march routine being the same as on manœuvres at home. At about noon on the

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27th we halted on the canal at St. Quentin. We had three hours here for washing, feeding, and sleeping, and then on again into our bivouac at 7 p.m. We had thus been on our legs practically since 8 a.m. the previous day, and were pretty well done. Most of the men got a good sleep and a dinner, but some, and most of the officers, were up all night preparing the bridges over the canal for demolition. We left these bridges eventually in the hands of the Field Squadron, R.E., to blow up, but I never heard if they did it. I know we had some trouble long after with them about some of their exploders which they said we had stolen.

Next morning, 28th, we were off again at 4 o'clock, but there was much delay in starting. This was dangerous, as we heard the Germans were on our heels. The delay was caused by the Ammunition Columns and Field Ambulance that had gone ahead. I got a message that a broken down traction engine was blocking the road, and that I was to blow it up. I went off with cyclists and a tool cart with a six-horse team at a gallop, but could find no engine, only some mounted unit calmly watering and holding us all up. I was told to leave my Company and keep chasing these people along all day, which I did until we got to Noyon, when I picked up my own Company and a staff officer, who told us we were to be put into trains and taken away for a rest!

Noyon was blocked with wagons, and we had a good deal of difficulty getting through. However we got on eventually, and were very happy to see our bivouac near Pontoise. All was peaceful, and we were told we should have a day's rest. Heavens, how we slept, and the luxury of a shave! Our bridging wagons rejoined us here, after wandering about for two days. I thought they must have been taken. Next day, 29th, at about 4 p.m., we were ordered to prepare five bridges on the Oise for demolition, and to let them go when the last troops were over. The H.Q. of the Company to continue the retreat that night. The four sections moved up to the river and we set to work. The bridges were all steel girders and it was a lengthy job. Another complication was that no one would or could tell who was to give the word to fire. I had a curious experience that evening. I was going from one bridge to another when I met a small party of French cavalry—some officers and an escort of Cuirassiers. I was struck by the strict way they questioned me in perfect English. I believed there were no French troops about, and I could hear the firing on the north of the river. I got very suspicious and told them nothing. That night I had a runner shot by Germans right behind the river, and I think the men I saw must have been Germans in disguise. However, all went well, we got our bridges down and away safely at 4 a.m., marching outside the rear guard as far as I remember.

About 8 a.m. this morning, 30th, I got a message by motor cyclist

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from the 2nd in Command of the West Kents in the 13th Brigade that the Suspension Bridge at Pontoise was not properly down, and could I do anything? Pontoise was 2½ hours march back, say about 7 or 8 miles outside rear guard. What was to be done? However one of my subalterns came forward and volunteered for the job. I told him I would not order him, as I thought it almost impossible. However, he pressed me so that I let him go. He first put 14 lbs. of gun cotton on the carrier of the motor bike, filled his pockets with fuzed detonators, mounted on top of the gun cotton, and off this priceless pair started. I wondered if I should ever see them again. I warned them that the charges must be put on top of the piers, not in the centre of the bridge.

About four hours after they both turned up smiling. They got down to the river safely and saw no Germans, mounted one pier, placed and lighted their charge; result, a misfire. Nothing daunted they put in new detonators, and got it off successfully; the shock pulled the cable off the other pier and made a good job of it. They were both awarded the D.S.O., and well they deserved it. This reminds me of the subaltern of the 17th F. Company, who set off a misfired charge on the Mons canal by a well-directed revolver bullet. He was a beautiful shot with a revolver, but must have been dangerously close to bring off this coup. He was killed by a shell at Hooge in the second battle of Ypres in 1915.

This venture cleared me out of explosives and no one could produce any more and this therefore was the last bridge demolished. I am glad to say that though we destroyed, I think it was, eleven bridges in all we never had a failure, but we never spared guncotton. I think that is a very wholesome rule to follow when you are in a hurry. The French engineers destroyed the bridges by which we crossed the Marne. We pursued our way pretty peacefully after this. Only once did we have any excitement, namely at Crèpy en Valois. We were with the rear guard and the Germans were close behind and were shelling. I got an order to entrench a position for an unknown number of men. I started as quickly as I could and then a staff officer came to look at us. He entirely disagreed with all I was doing so I said: "Perhaps you will say what should be done." He spent half an hour looking round, could not make up his mind, said he was busy and levanted, and glad I was to see the last of him. A few minutes later I got an order to continue my march and that was the last day I saw a shell burst during the great retreat. So we went on marching, marching incessantly. The agonies of want of sleep were indescribable. I have seen men fall down on the road as dead—they were dead with sleep. The longest nightmare has an end however and, at last, we reached the end of ours in a beautiful orchard at Tournon, a few miles (15 or so) south-east of Paris. We got in on Saturday morning and had a long rest that day and a

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good wash and shave and boots off. That night we were sent the cheerful news that "The British Army will advance." Those I think were the very words.

Now for a few points of military interest :—

March Discipline.—This was extraordinarily good and the discipline in camps and sanitation equally so. We left our camps as clean as on manœuvres. We had no stragglers but I was lucky, as I had two empty bridging wagons on which the lame ducks sat like crows on a fence. The only other people carried were the cooks and officers' servants, and the 14-year-old bugler who went through it all in the arms of my gigantic wheeler, Swan. I was very particular about marching in fours and keeping dressing and, when the men realized that it helped them, they did it without trouble. We were never short of food. One day I was asked what food I had for the next and said a full ration. The D.A. & Q.M.G. said : "You are very lucky as no one else has." It was the food I stole at Havre that pulled me through ! The maxim that "Heaven helps those that help themselves," may be bad morals, but in practice I have found it a useful one to follow.

Watering horses was our great difficulty. There was plenty of water about, but when the periodical halt came the mounted units were not always near the water. The horses did not get enough water and lost condition in consequence. The weather was sultry, the roads dusty and men and animals thirsty. Training will make a man do without water but an animal cannot be trained in this way. Another difficulty was that 75 per cent. of the horses were fat and soft when they started, harness had been rapidly fitted, and consequently there was much galling. Our spare pontoon teams were a great help and I don't think we ever lost a horse. What we did lose was harness. We used to march sick horses light and put harness up on any available wagon. Result, it got dumped when we started in the dark. Led horses should always be marched fully equipped. Even during this retreat we always attended to the men's feet regularly and with good results. My own personal difficulty was that I got my boots off so seldom, but the men had more opportunities than I had. A last word about orders. When I started, I always stayed up until Divisional Orders came in. The result was that a lot of people had to stay up too. I soon found that the best way was to arrange for a very early start and let everyone turn in early. Then, when the orders came in I usually had only to say, "Call us so much later" and everything went like clockwork.

I cannot remember the total casualties up to this but they were few and none of the officers were hit. Of 22 men missing at Le Cateau 12 turned up about a fortnight later having been half over France, as they said, in a train.

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The Advance.—We started from Tournon on September 6th full of life. To be going forward was like wine in our veins.

The two Field Companies took turns with the advance guard and as before, the 59th did not see much. It was a question of pushing in rear guards and there were no very serious obstacles to overcome. What I remember best was the joy of the inhabitants as we came along. Nothing was too good to give us and we were surfeited with the most beautiful fruit. It was a splendid country and the weather glorious also, and we were full of life and hope. I have forgotten the names of our various halting places from day to day except Mort Cerf and Villeneuve St. George and Coullomiers. Sometimes we had billets, more often bivouacs. We saw little of German atrocities except the horrible way they had turned the houses and cottages inside out, furniture broken, clothing thrown about and crockery and glass smashed on the floors. On one shutter of a house, however, I saw a legend in German to the effect that these were kind people and should not be molested. What did strike me however was the characteristic smell that pervaded every place that had been occupied by Germans. You could smell it in the open fields and as we marched along the roads.

The Marne.—At last, September 10th, we reached the Marne at a place called Mery. We marched down to the river in column of route and not a shot was fired. We were with the rear guard. Mery Bridge was intact, so there was nothing for us to do. When we got into the village we were told to park beside the road, and await orders. Meanwhile the battle was proceeding on the wooded heights above us. We could get no news and I rode off to see what I could of what was going on. The 14th Brigade was starting the attack in thick woods, and the 17th Company, R.E., was with them. It was heavy work, the fighting stubborn and the casualties heavy. Still I got no news or orders. About 3 p.m. some sort of flank move was made against the German rear guard and they began to withdraw, and the battle died down. We bivouacked where we had been halted all day, and late that night got orders to move with the advance guard at 5 a.m. The pursuit was taken up again on this morning (11th) and as we marched we passed a great many dead on the roadside, mostly 14th Brigade, I think, but still we had won our battle and all were cheerful. The Division had been very lucky in finding a bridge in being and in not having to use pontoons under fire as was the case with the Division on our left at La Ferté sous Jouarre.

We moved on rapidly meeting with little serious opposition. One day with the advance guard we saw a German column knocked to pieces by our guns as they marched along a road, lined with poplars, on a skyline. When we got there it was almost a ludicrous scene—wagons overturned, cookers abandoned and equipment lying about.

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The dead and wounded horses however struck a tragic note. I here saw my first German prisoner. He was a wretched little creature about 5ft. high, with feet so sore that he could not put them on the ground. Poor little devil he thought he was going to have his throat cut and tears were streaming down his cheeks. His captors, the Norfolks, however perched him on the back of a water cart and plied him assiduously with biscuits and cigarettes. That night we had a good bivouac, and an alarm which turned out to be a mare's nest, British being mistaken for German cavalry.

On we went next day in rain and filth for the weather had broken, through Chacrise and on Sunday, 13th, we arrived at Serches. A lovely morning and the forerunner of fine weather. We were with the advanced guard and as we passed along up the hill behind Serches I was ordered to send an officer to reconnoitre the bridge over the Aisne at Missy. I sent off Pennycuick and some cyclists and then pushed on over the Serche Ridge down into the Aisne Valley to Ciry. I think we were the first dismounted troops to go down. I parked the company at Ciry, and went on to Ciry station to reconnoitre. I often wonder now who was in front of me; I doubt if there was anyone!

The Battle of the Aisne.—It can hardly be called a battle in the ordinary sense though we did make one attack, after the failure of which, we settled down to consolidate, which amusement occupied us until about the 1st October. To return to our experiences on the 13th September. The road down from the heights above Serches to Ciry was in full view of the enemy. No hedges, no cover, and the descent to Ciry was down a long hill in full view of the enemy. I thought as I went over the crest that we were "for it" in real earnest. The men marched in file on either side of the road, the wagons following us. However nothing happened and we got safely down, though a field ambulance that followed later got it hot and strong. One of my sections, No. 1 under Sergt. Buckle, that had been left behind at first, saw this unpleasantly close, but as far as I remember lost no one. I was thankful that we got safely into Ciry village and we hid ourselves pretty well so they did not trouble us with shells. I went on to the station with a few people to look for material to rebuild Missy Bridge. I did not find much, and meanwhile got Pennycuick's report, which said that he could only reconnoitre the bridge with glasses. He is commonly believed to have done the work on a raft, but that is an error. He gave me a sketch of the bridge which was, I found when I got on to it later in the day, short of one 50-ft. span. There were three such in all and two were broken. The piers were 15 ft. high and the water 10 to 12 ft. deep. A nice job for a Field Company with nothing but what they carried in tool carts.

Towards 3 p.m. I got a message from the West Kent Regiment,

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13th Brigade, that they were ordered to cross at Missy at all costs, and could I help them. I met the Colonel and told him I would collect such stuff as I could in Sermoise, which was about 1,000 yards from the bridge, and I sent for the company to meet me there. Of course there was nothing of much use, but such as there was we took along with us, with the aid of a carrying party of the West Kents. The battalion pushed on to the river and had a tough fight to clear the Germans from their end of Missy Bridge. I got down to the bridge at the same time as the second-in-command of the West Kents and we went on the bridge together to find it as I have described above. We were I think the first Englishmen to get on to it. I saw that nothing could be done to make it fit to cross under two or three days, so I said we must try rafts. As we stood on the bank considering this a machine gun, one of the few left, opened fire over our heads at the bridge, I presume on the assumption that we, when on the bridge, were Germans. The gunner was rather erratic at first, and got our orderly in the leg but his aim improved later and he plastered the bridge well; I know I never lay flatter in my life until the performance was over. Then we got to business. We made five rafts—one of planks and three of straw and wagon covers. Each would float five men. We sent a man over swimming with a hambro line and got cables over and with this outfit the crossing started. I may say here that we were entirely unmolested. The sappers manœuvred the rafts at first until the infantry were trained and then the latter carried on. To make a long story short three battalions, 13th Brigade, got over before daybreak 14th. It was, in my opinion, the best job we did during the time I was with the company. While we were all on the river our H.Q. and horses, etc., were in Sermoise and they had a very bad time. Apparently the Germans did not spot us on the river and thought we were in the village. They killed some and stampeded the rest of the outfit and when I got back I found them very much shaken. I and the company were as usual on such occasions reported dead by the sole survivor who got away.

Next morning, 14th, I got the wagons out to the east to a farm near Ciry station where they formed a good billet which however got too hot for us later on. The rest of us returned to the river. I and the Captain (W. H. Johnston) made a section for a trestle bridge under rather fiery circumstances, as the Germans had found us by now. Long afterwards I heard the explanation of our immunity the night before. It appeared that the first five men of the West Kents killed the whole of a German patrol of six on the north bank of the river, so that no news of our movements got back.

I must now return to Johnston and the river. After completing the section I left him to make some corrections and went off to visit one of the other sections. While I was away a violent battle started

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in Missy and the river was covered with bullets. I came back soon after to join Johnston but when I got near him he signalled me not to approach. He and Flint were working a raft to and fro—carrying wounded one way and ammunition the other. I sat down under cover with Pennycuick and a few men ready to assist and so we spent the day. Buckle with his section were close by also. Johnston and Flint continued this work until 7 p.m. when they were relieved, quite worn out. Johnston received a V.C. for this and Flint a D.S.O. I was able to recommend them personally as I saw it all.

The battle at Missy had died down and the night was fairly quiet and we withdrew to sleep and feed. I spoke above of our having attacked the Germans on the Aisne. This attack was carried out by the 14th Brigade against Chievres Ridge. The Brigade crossed on a pontoon bridge made by the 17th Company, R.E., at Venizel and after being repulsed withdrew and held Missy village, the 17th Company were with them. The 13th Brigade were withdrawn south of the river and we remained with them during the rest of the operations, digging trenches, preparing the trestle bridge, which was never made, and working on retired line defences. We lived at Ciry station for some time but eventually were shelled out and took up our quarters at Couvrelles Chateau where we had good beds, electric light, and fed on the fat of the land.

One more incident remains to be mentioned namely the light infantry bridge at Missy. It is interesting from the R.E. point of view. The bridge train brought up their gear to Venizel, where we unloaded and made up rafts. These we navigated up river for two miles in the dark by towing and rowing to the site of the bridge, which had been selected just out of view of the opposite heights. We were really hidden by a wood. On arrival we dismantled the rafts and disembarked the stores and then started our light bridge. Such a riot I have seldom seen or seldom heard. The majority of the men were untrained, and it was only by the mercy of heaven, and our N.C.O.'s that we got it through. I expected shelling every moment, but it never came, in fact, no shot was fired at us. We were done at midnight and so to bed, and Missy was at last safely joined up to the south bank. I say safely advisedly, as this bridge was never hit while I was there.

This I think finishes our experiences on the Aisne. We did many odds and ends and suffered little. We left by stealth on the night of the 1st October for our march *viâ* Villers Cotteret to Pont à Maxance, where we entrained for the north.

So ends my narrative. It is scrappy no doubt but the time is long past and I have seen many things since then, but none that interested me more. What has impressed me most in looking back is not the memories of the incidents, exciting though they were, but

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the thought of how much our successes depended upon the old-fashioned training. First, the training of the officers at school and in the military colleges, a training, the essence of which was the suppression of the individual for the benefit of his fellows and secondly the training of the men, first, in the technicalities of soldiering and then in the belief in his officer, which was the hall-mark, so to speak, of all good regiments. I believe that nothing counts so much in the army than the old-fashioned relationship between officer and man. It was a real brotherhood. The men had a standard which they expected from their officer—knowledge, uprightness, justice, and leadership, and if that standard was attained they would follow them to death quite cheerfully. I believe that standard was attained and I believe that it was this that made our men so steadfast. I remember speaking to the men of the 59th Company on parade at the Curragh just before we marched off to the train on the 16th August. I said to them I had never been let down by a sapper in my life, and that I knew that whatever happened to us they would always behave like gentlemen. I was answered by a growl of " Hear, hear " from the ranks and I knew that I had those men behind me in good and evil times as long as they were alive. Nobly they kept their word. Nothing was too much for them, and never did they waver. I owe them a debt of gratitude that can never be repaid.

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MEMOIR.

BREVET MAJOR W. H. JOHNSTON, V.C., R.E.

THE subject of this notice was the son of the late Major and Riding Master W. Johnston, Royal Artillery. He was born on 21st December, 1880. He was educated privately, and at the Boys' High School, Woolwich, under the late C. L. Draper, D.S.C., and then at Bosworth & Stern's, at Roehampton, and the R.M.A., Woolwich, from which he passed into the Royal Engineers, and was gazetted a Second Lieutenant on 23rd of March, 1897.

After the usual course at the S.M.E. Johnston served for five years at Gibraltar, and on his return home went to the Survey and subsequently to North China, where he was employed on the staff for four years. His work in China was of an important and confidential nature, and he received great credit for the way in which he carried it out. After his return from China in July, 1912, he was employed for short periods at the War Office, Chatham, and at Bulford until he joined the Staff College in January, 1914.

At the outbreak of war Johnston, then a Captain, joined the 59th Field Company, R.E., which belonged to the 5th Division, and was stationed at the Curragh, as its Captain. The other officers were myself (in command), with Pennycuick, Flint, Stevenson and Carr, as subalterns. I remember he joined us one morning after a dreadful journey from England, during which he had lost his kit and his horse, and was more dead than alive. His only anxiety having been to join as quickly as possible.

We had a very strenuous fortnight mobilizing, during which Johnston did more than his share of the work, until he eventually started off with the mounted party by road for the North Wall, Dublin, where we all embarked together on the 16th of August.

All through the subsequent weeks, at Mons, Le Cateau, during the retreat, at the Marne, the Aisne, and in the first battle of Ypres, he was the life and soul of the party. He seemed to enjoy fighting. I remember his saying with glee as we went up in the train from Havre, "I expect we shall be scrapping in a couple of days now." He certainly was right.

On the Aisne he performed the service which won him his V.C. We had been together on the river all the early morning, and I had left him to go and see one of the sections of the Company that was in

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trouble. When I came back to the river I found him on the raft with Flint, carrying the wounded back and the ammunition forward to the troops in Missy Village. These two continued to carry out this work all day, and well they earned their rewards (Flint was given a D.S.O.).

From the Aisne we went up to Bethune and Richbourg L'Avoue, and from thence to Bailleul and Neuve Eglise, then on to Ypres, where the first battle was raging. We had 14 strenuous days of it, and were then relieved by the French. Johnston took over command of the company after this, as I went sick, and was subsequently attached to the 2nd Corps Headquarters. His command was a great success, and I think he was one of the best known personalities in the 5th Division.

It was during this time, about January, 1915, that he was selected to command the first Tunnelling Company raised in the Second Army. It was important that the organization and tone of the first unit should be good and Johnston was the best man that could have been chosen. At first he chafed terribly at the idea, but Sir Horace Smith-Dorrien and Sir Charles Fergusson were sure of their choice, and he nobly justified it. I have met some of his men since then, and their respect, almost reverence, for him was wonderful.

I personally saw but little of Johnston after March, 1915, as we were in different parts of the country. I saw him, however, just after he had been appointed Brigade Major, 15th Infantry Brigade, in May, 1915. We never met again as he was killed soon after, near Hill 60.

He was so pleased that he had got his heart's desire, and it was a tragedy that he was not permitted to keep it.

His death was a terrible blow to his friends and a great loss to the British Army and the Corps of Royal Engineers.

I personally was fortunate enough to become very intimate with him during our short friendship, and his high qualities of head and heart were wonderful. He was a fiery soldier, and as gentle as a woman. The men followed him like children. His religion was the mainspring of all his actions. I doubt if any man can have higher praise.

But his own gentleness and chivalry made him stern and uncompromising in his judgment of all that has stained the record of the German in warfare. In the few brief days of leave which he had in December 1914 his friends asked him his opinion of the German as a soldier, and also as to the truth about the Belgian atrocities. He replied that he had heard tales of atrocities, but had never seen evidence of such, and that so far as his own personal experience went he was convinced that the German was a brave, hard, and clever fighter. The crucifixion of a Canadian, and later the use of gas by the enemy in April, 1915, of which he was an eye-witness, stirred

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him to the depths of his being, and that there may remain a record of the effect which wickedness and inhumanity of this type had upon us who experienced it I quote from a letter from Sir William Furse who knew Johnston well. He says of him, "I never met, even amongst the many hundreds of splendid, devoted and hard-working officers I have come across in the last four years, anyone whose conception of duty was higher than it was with Johnston. His personal bravery was just amazing. I never met any officer who so entirely devoted his energies to thinking out means of destroying the enemy. I shall never forget a conversation in my office just after the Hun first attack in April, 1915, with gas. My brother, the Bishop of Pretoria, was, as we all were, exasperated by the enemy having made use of this muck against all the laws of civilized warfare and expressed the hope that it would not be found necessary for us to copy him." After Johnston had finished his business with me I remember his referring to this conversation and saying, "You know, personally, I do not agree with your brother. I would stick at nothing in the way of devices for killing Huns. Indeed, when my turn comes, I should feel happy if I knew my body would be dropped in a well from which the Huns would draw their drinking water."

Such an opinion expressed by a Christian English gentleman, for such Johnston most certainly was, may shock some people, but I expect that if these people had gone through some of our experiences they would probably share our feelings. That he, who was the soul of gentleness should have been forced into such condemnation of an enemy, whom he began by respecting, is for us, who knew him, not only the most severe indictment of the foe, but also an exhortation to the task of so educating the conscience of mankind, that such fiendish devices may never again stain the annals of war.

In conclusion I can only say, that although Johnston's death was a grievous loss to us all, his ideals and the example he set in trying to live up to them are a precious legacy to all those who had the privilege of knowing and serving with him, and to the country which he served so devotedly.

G. WALKER, *Brig.-General.*

21st February, 1919.

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Bt.-Major W. H. Johnston, V.C., R.E.

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CORRESPONDENCE.

FUTURE TACTICS.

To the Editor of the *R.E. Journal*.

Sir,

Brig.-General Schreiber, in his article on future tactics, indicates the lines upon which thought and discussion on this subject should progress.

After our great successful advance in France it seems right that our thoughts should turn to the attack, and I venture to think that our Army Chiefs, from the beginning, were always looking forward to the day, when the vicissitudes and trials of their great defensive action would bear their hoped for fruit, and make us able once more to attack. I sincerely hope that all our schoolmen of the future will teach the principles of defence in this way, namely, that all defensive measures must be looked upon as a preliminary or auxiliary to the offensive.

Engineers are prone at times to take a somewhat short view of their work. All this, however, does not minimise the importance of our endeavouring to evolve the most suitable methods of defence to meet the weapons of the times. I do not propose to enter into any details but just to touch upon two aspects of the question indicated by General Schreiber. He alludes to the two schools of ideas whose respective watchwords have been continuous lines and *points d'appui*. I do not propose to father either of them in this letter, but I wish to make a digression to drag in a subject, which I believe has an important bearing upon any discussion as between the merits of these two, or any other schools of theory.

I have, I at least consider fortunately, been serving with troops, except for one short period, throughout my service. If this experience has taught me anything, it has taught me that an officer who has no knowledge of the mentality, psychology, call it what you will, of his men, and who is not in sympathy with them, is not fit to lead them in the field. It is the old story of "the proper study of mankind." Now, how does this affect our question? I remember, years ago, the present Lord Sydenham declaiming against what he called, I think, the drawing-board school of military engineers. Let us beware of following too blindly the text-book soldier. Not that I decry text-books that give the result of the experiences of war, far from it, but I do decry those who in their theoretical keeness drive theories too hard.

We theorists, I was one once, took our theories before the war from Germany, from France, and from almost anywhere, so long as they were

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not home grown. Did we ever stop to think what manner of man he was, who would have to put those theories to the test in practice and whose blood was to be the sacrifice, if those theories were wrong? I speak of the "man who works the bayonet." I am putting it this way because I went to the war myself in command of a field company and stuffed to the muzzle with the latest ideas concerning *points d'appui*, defended localities, mutual support, the power of the modern rifle, etc., etc. I believed it all, it worked out beautifully on paper, and when I first went into action I found the man with the bayonet would have none of it. It may seem curious, because he had been taught it too; but, when he was out alone he began to think about darkness, fog, how he was to know who was on his right and left, and what was happening there; and he suddenly realized what he wanted and *he* declared with oaths that it had nothing to do with *points d'appui*." That is what he thought at the beginning and that is what I imagine he thinks now. He may be a poor theorist, but he is the greatest fighting animal on earth.

To turn to the original French system. They evolved it because it suited them. They preferred not to be "shelled to Hell" in the front line, but rather to retake it by assault from a retired position. The British officer and man, I believe, hated to allow a German to even take a yard of his front line, and they were prepared to lump the shelling. A difference of temperament, possibly of good taste, but a difference that commanders have to reckon with when putting theory into practice.

I have no wish to criticize anyone and I have written this letter with the sole object of putting a point of view before those who are better able than myself to continue this discussion. Put shortly, I believe that all theories for giving effect to the great principles of war should take into consideration the mentality of the troops that will be called upon to carry them out.

Yours faithfully,

G. WALKER, *Brig.-General.*

2, Carlton Gardens, S.W. 1.
10th March, 1919.

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REVIEWS.

SYNOPSIS OF MILITARY LAW AND DISCIPLINE.

This work (which with the two below are issued by the A.S.C. Printing Works, Aldershot) is an attempt to produce in a condensed and easily accessible form all the ordinary rules and regulations governing Arrest, Investigation of Charges, Assessment of Fines and Awards, preparation of Charge and Guard Reports, Conduct Sheets, and all other matters met with in the daily routine of the disposal of military offenders. It gives clearly, fully, and in proper sequence the various stages in the disposal of the accused from the moment of arrest until the case passes into the hands of a Court Martial. It is well indexed, and fully referenced. It should be of great value to students either as a synopsis of these rather unhandy volumes *The Manual of Military Law* and *King's Regulations*, or even as a supplementary index to them, and will also be found useful for ready reference by officers who may be rusty in the subject.

FEEDING STUFFS AS APPLIED TO THE MANAGEMENT OF ARMY HORSES.

THIS book contains in Chapter I. a short treatise on Equine Dietetics, and in the remaining chapters deals in detail with the inspection and correct use of the various types of Feeding Stuffs. It does not add much to Chapter V. Animal Management, except as regards the use and advantages of cooked maize (of which the writer has had special experience), and omits a good deal. It is designed to "facilitate the instruction of Officers and Cadets of Mounted Units in these subjects." The price of the work is 1s. 6d.

THE ART OF PRACTICAL HORSE SHOEING.

THIS handy little book describes briefly but clearly the structure of the foot, the main points in the actual operation of shoeing and the chief ailments of the foot to the extent that is necessary for a shoeing smith in order that he may assist in the relief or treatment by suitable shoeing. It should be of value to young shoers and also to others concerned with horse-mastership, who have not ready access to Chapter VII., "Animal Management." The work is issued at 6d. per copy.

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PAGES D'HISTOIRE, 1914—1918.

(Librairie Militaire Berger-Levrault, 5—7 Rue des Beaux Arts, Paris).

(*Continued from R.E. Journal for February*, 1919).

The 153rd number of this series contains the official communiqués issued by the Central Government at Paris to the Provincial Authorities in France during the first three months of the year 1918; it is the XXXVI. volume dealing with such matters. In an Appendix are given the texts of the New Year's greetings addressed by the Sovereigns of Great Britain, Serbia, and Greece, and by Prince Alexander of Serbia to the President of the French Republic; the replies sent by the latter to the foregoing messages are also published.

The 154th number of the series is entitled *Le Mémoire Lichnowsky et les Documents Muehlon;* it is provided with a Preface written by M. Joseph Reinach (Polybe).

The Preface is headed *Une page d'histoire*, and therein M. Reinach declares that Charles Max, Sixth Prince Lichnowsky, Lord of Woschtüz, may thank the gods he has retained something of the human being about him. The great majority of his compatriots call him "traitor," he has been too conscientious to become a hero in the Fatherland, he did not wish to have buried with him in his tomb the particles of truth which were in his possession.

One of the most important of the German lies has been that Great Britain, jealous of peacably-minded and honest Germany, planned the Great War; mistress of the seas, she wished also to become Lord Paramount of the Continents of the World.

This is not the first time in the history of great political or judicial crimes that the offender has endeavoured to escape responsibility for his own acts and designs by imputing them to his victims. Lichnowsky, from his official position, was well aware of the continual effort Great Britain made, over a long period of years, to live in peace and harmony with Germany, and particularly, during the twelve critical days preceding the War, to avert the impending catastrophe.

On his return to Berlin, Lichnowsky remained silent. Nevertheless, he was indignant at the insolent and bare-faced lies, told by the Kaiser himself, charging Great Britain with responsibility for the war; lies which all Germany recklessly accepted. The irreparable mischief h d been done; Lichnowsky's country was at war, but it was not fear that caused him to hold his tongue. His country was at fault; however, his patriotism was too sound to permit him openly to accuse the Fatherland, at a critical period of its history, of the crime of having provoked a most barbarous war. Nevertheless, Lichnowsky did not wish, in the years to come, to be numbered amongst the instigators of the outrage on civilization. He, therefore, put on record an account of his mission at

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the Court of St. James (1912—1914) for the sake of posterity. The document was prepared in all sincerity and with perfect frankness; it is free from bias and signs of ace bity; matters are recorded therein as they occurred.

Now comes the drama. The manuscript was kept by Lichnowsky locked up in a drawer. The war was lasting longer than anticipated; doubts began to arise as to the possibility of Germany winning a victory. The hatred of the world towards Germany was increasing. Lichnowsky read over his memoirs and, in view of the disastrous situation with which his country was faced, formed the opinion that some of his countrymen should be in possession of his secrets, in order that a little light might be thrown on the path they were treading. Under the seal of secrecy, Lichnowsky let a few trusted f iends have copies of his memoirs. These friends had other friends and, thinking that they would be performing a useful service, passed on to the latter the information given them. Thus it was that a copy of the memoirs fell into the hands of the editor of a Swedish newspaper who published the same to the wide world.

The information contained in Lichnowsky's memoirs added no new knowledge to that which was already known in Great Britain, France, Serbia, and Russia. But in Germany the publication of the document caused great consternation; her people either did not know, or had not wished to know, that which the ex-Ambassador has placed on record in his memoirs. The Germans now know that their Emperor was responsible for the great calamity which overtook Europe in the autumn of 1914. He it was that urged Austria on " to attack Serbia although no German interest was threatened and he well knew that the danger existed of the war becoming world-wide." A hint from Wilhelm II. to Austria that she should content herself with a diplomatic success would have enabled her to adjust her policy accordingly, but that hint was never given. On the contrary, the view at the Wilhelmstrasse was that Serbia should be utterly destroyed (*massakriert*). It was Germany that declared war against Russia, although the Czar had given his word of honour that the Russian Army would not advance whilst the negotiations then in progress continued.

Lichnowsky was the first person to suffer from the publicity given to his memoirs. He was deprived of his seat in the Prussian House of Peers.

Lichnowsky, however, is not the only German who has had the courage of his convictions. Muehlon, a former director of Krupp's works, has, in his turn, come forward to depose that the text of Austria's ultimatum to Serbia was well known at the Wilhemstrasse; that, indeed, its text was edited at a secret conclave at Potsdam; that the visit of the Hohenzollern autocrat, on board the Imperial Yacht, o the No wegian Fjords wa but a " blind "; the war had already been planned, its date fixed.

But little had changed in Germany at the time that M. Reinach wrote the Preface, except that the Kaiser, the Crown Prince, and the German Generals and Ministers no longer denounced Great Britain as the instigator of the war.

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Lichnowsky's Memoirs.

The memoirs begin with a statement as to the circumstances under which Lichnowsky was appointed German Ambassador at the Court of St. James. Baron Marshall had died somewhat suddenly in September, 1912; his appointment is said to have been one of the numerous errors committed by the old *régime* at the Wilhemstrasse. Baron Marshall was a stranger to Anglo-Saxon ideas and was too old, when he arrived in this country, to adapt himself to his surroundings. He was an official rather than a diplomat. He was called upon to persuade the British people that the German Navy was no menace to Great Britain; however, he failed to do so and on the contrary confirmed the opinion then held in this country on the subject.

When Lichnowsky was offered, in October, 1912, the vacant Ambassadorship in London, he had already been on the unemployed list for eight years. Five years earlier he had quitted Vienna with the title of Minister and his last appointment in Germany had been that of Director in charge of the staff of the German Foreign Office.

Candidates nominated for important positions by the Kaiser were, as a rule, opposed by the German Foreign Office. Lichnowsky, therefore, feels that his appointment was not due to Wilhelm II. He tells us that von Kiderlen, the then Foreign Minister, wished to send von Stumm to London and received Lichnowsky, on his visiting the Wilhelmstrasse, in a rude manner, hoping thus to intimidate him. Von Bethmann-Hollweg was, at this time, well-disposed towards the ex-Ambassador and had very recently visited him at Grätz.

At the date that Lichnowsky was sent to London, it might have been the intention of the Wilhelmstrasse to make an attempt to improve the relations between the German Empire and the British; more particularly so as the enigmatical policy being pursued in Morocco by Berlin had almost completely destroyed the confidence of the world in Germany, and it was even then suspected that she was preparing for war and seized every opportunity to humiliate France. An Austrian colleague once remarked to Lichnowsky in Paris: "Every time that the French we e beginning to forget '*la revanche*,' you have regularly quickened their memories by a vigorous kick."

Germany repelled all attempts made by Delcassé to arrive at an understanding with Berlin on the subject of Morocco, although she had solemnly announced that she had no political interests in that region. A second Krüger was discovered in the person of Abd-ul-Aziz, and, as happened in the case of the Boers, he was promised the protection of the mighty German Empire. As was the case in S. Africa in 1896, so years later in N. Africa, Germany had to beat an ignominious diplomatic retreat. Neither the Algeçiras Congress, nor the fall of Delcassé helped Germany to "save face."

The German peril was responsible for the Russo-Japanese *rapprochement*, and later for the Russo-British *rapprochement*. The possibility of a new Franco-German War, in the immediate future, was borne in upon all thoughtful persons; it was realized, at the same time, that Russia and Great Britain would not be able, as in 1870, to stand outside the ring.

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The Conference at Algeçiras disclosed the real value of the Triple Alliance. The events that succeeded that Conference showed that the agreements entered into at Algeçiras were valueless. The German people, at the same time, formed the opinion that the foreign policy of France was weak and would collapse in face of the German "encirclement."

Finally, the Agadir incident increased the suspicions regarding German designs; indeed, to so great an extent that Mr. Lloyd George publicly warned Germany of the dangers she was running in pursuing her misdirected policy in Morocco. Prior to Delcassé's fall and the Algeçiras Conference, Germany might have obtained a port and territorial concessions in the western regions of Morocco; it now became impossible.

Lichnowsky tells us that when he took up his appointment in London in November, 1912, the Morocco question had adjusted itself. France and Germany had arrived at an understanding. On the other hand, the Haldane Mission had failed, owing to Germany's impudent demand that Great Britain should promise to remain neutral in the event of the outbreak of hostilities. Sir Edward Grey, however, had not given up all idea of arriving at an understanding with Germany. He first turned his attention to the colonial situation and the sphere of economics for the purpose of reaching some common ground for agreement. Pourparlers had been entered into in relation to the renewal of a Treaty regarding the Portuguese Colonies and with regard to Mesopotamia (*i.e.*, the Baghdad railway)—the idea was to lay down spheres of influence in connection with these Colonies and also in Asia Minor.

The British Statesmen, says Lichnowsky, having arranged their many differences with France, were desirous of doing the same in the case of their differences with Germany. Sir Edward Grey's programme aimed at bringing about a *rapprochement* with Germany, without disturbing the then existing alliance between France and Russia; he wished "to bring the two groups nearer."

There were in Germany, as in Great Britain, at the time two factions; the optimists, who believed that an understanding could be reached, and the pessimists, who were convinced that war was inevitable sooner or later.

So far as Great Britain was concerned, Lichnowsky places the following individuals and newspapers in the former category—Lord Haldane, Sir Ed. Grey, Mr. Asquith, the majority of the Radical members of the Cabinet, the *Westminster Gazette*, *Manchester Guardian*, and the *Daily Chronicle*. Among the pessimists the ex-Ambassador ranks Mr. Balfour and the politicians belonging to the Conservative Party, the late Lord Roberts, the *Observer* and the Northcliffe Press.

Lichnowsky next calls attention to the fact that the First Balkan War brought about the dismemberment of the Turkish Empire, and therefore, resulted in a defeat for German diplomacy. Two courses were open to the Germany at the time; on the one hand, to take up the attitude that she had no interest or concern whatever in the settlement of the frontiers of the Balkan Countries but left it to them to work out the proper solution; on the other hand, to stand by her allies.

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Lichnowsky favoured the adoption of the former course, but the German Foreign Office decided to pursue the latter course, the diplomacy of the Triplice. The critical situation was that in relation to Albania. Germany's allies wished to see Albania created an independent state; Austria was desirous of preventing Serbia having a seaboard on the Adriatic, whilst Italy was anxious that Greece should not be allowed to extend as far as Valona, or even north of Corfu. On the other hand, Russia supported the claims of Serbia, and France those of Greece.

Lichnowsky is of opinion that had Serbia been given a "window by the sea" the Great War might have been avoided. On the other hand, a serious difference would have arisen between France and Italy with regard to the aspirations of Greece. The Italians, however, would not have risked a rupture single-handed with the French and, in consequence, would have become resigned to the extension of the Greek frontiers to the north of Janina—a great part of the population of Albania is of Greek origin. Lichnowsky's attitude on the subject caused him to be looked upon as an "enemy of Austria"; and he was reproached by the Imperial Chancellor for holding the views which he did.

The ex-Ambassador is of opinion that Germany would have acted wisely if she had freed herself from the fatal diplomacy of the Triple Alliance in the East and had recognized that it was a serious mistake for her to ally herself with the Turks in the South and the Austro-Magyars in the North. By pursuing the policy inaugurated at the Congress of Berlin, Germany was bound sooner or later, in the absence of highly-skilled statesmanship in her rulers, to come into collision with Russia. Instead of arriving at an understanding with Russia regarding the principle of the independence of the Sultan, instead of refraining from military and political interference at Constantinople and being content with safeguarding Germany's economic interests by agreeing to spheres of influence in Asia Minor, the Wilhelmstrasse aimed at establishing Teutonic dominance on both banks of the Bosphorus. German ambitions caused a feeling to grow up at Petrograd that, so far as Russia was concerned, all roads to Constantinople and the Mediterranean lay through Berlin. Instead of encouraging the development of the Balkan States, which, once that they had been emancipated, would not have been strongly Russophil, Germany deliberately ranged herself on the side of the Turkish and Magyar oppressors.

Germany's mistaken policy in the Near East pushed Russia, which should have been her best friend, into the arms of France and Great Britain and caused her to abandon her policy of expansion in Asia.

Lichnowsky considers it useless to discuss the value of Germany's alliance with Italy. The latter country, he says, was in need of German money and German tourists, even after the war, with or without an alliance. There should have been no difficulty in foreseeing that, in the event of war, the Italian alliance would have *no value*. Austria was in need of German protection in peace as well as in war; such protection was necessary on political, national and economic grounds. Had Germany adopted a proper policy and succeeded in maintaining good relations with Russia, Austria must have become the former's vassal.

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Under such circumstances Austria would have been bound to take her cue from Berlin. On the other hand, with Germany's policy badly managed and ill-directed as it was, it became necessary for her to shape her course to suit the needs of Vienna. According to Lichnowsky, the alliance was, in consequence, *purposeless*.

The alliance between Germany and Austria had, at the time of its formation, only a single eventuality in contemplation; but by transforming it into one of a complete community of interests, in whatever domain those interests might lie, the alliance acted as provocative of just that very thing that it had been created to avoid, namely, war. The alliance also deprived Germany of the sympathies of young and energetic States, which were in the ascendant and whose markets should have been secured for German goods.

In recent times Germany has always managed to back the wrong horse; first it was Krüger, then in turn Abd-ul-Aziz, Abd-ul-Hamid, William of Wied, and, finally, a great plunge was made on the Berchtold stable, with disastrous results, as it now proves.

Lichnowsky tells us that shortly after his arrival in London, towards the end of 1912, Sir Edward Grey exchanged views with the Ambassadors at the Court of St. James; he endeavoured, without binding the parties thereto, to come to an understanding whereby an outbreak of hostilities in the Balkans might be localized in such a manner as to prevent its involving a general European war.

Sir Edward Grey took up the attitude that as Great Britain had no interests in Albania, she did not want to be dragged into a war on this question. He desired to act as a mediator to smooth the difficulties arising from the differences between the parties; he by no means took the side of his associates, namely, the Entente Powers. During the eight months that the matter was under discussion, by his good will and influence, he helped to a great extent in bringing the pa ties into agreement. Germany, instead of acting in a similar spirit, was always taking up the cudgels on behalf of Austria and following the dictation of Vienna. Count Mensdorff was the spokesman for the Triple Alliance in London; Lichnowsky was, according to his own account, "second fiddle," and it devolved upon him to support the Austrian Ambassador.

Lichnowsky acknowledges that Sir Edward Grey directed the negotiations with prudence, harmony, and tact. He steered the bark of diplomacy through troubled waters with skill. His personality inspired confidence in all the parties to the negotiations. Germany, however, continued on her ill-chosen course, and, although it was leading her over the precipice, no attempt was made to cry a halt.

The Russian Ambassador, Count Benckendorff, seems to have created a favourable impression on Lichnowsky, who gives him credit for possessing many of the desirable qualities required in a diplomat and also admits that the Count, during the critical negotiations, showed himself ready to follow the pacific tendencies of Great Britain and France.

The Conference on the Balkan Question took place in London about this time and Lichnowsky was thus brought into contact with the distinguished personages representing the Balkan States. M. Venizelos

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proved an attractive personality to the German ex-Ambassador; the Greek statesman showed himself to be a man of the world and one possessing the art of winning the sympathies of others. Mention is also made of M. Danew, the Bulgarian Premier, and M. Take Jonesco, the Roumanian statesman. The former was a man of energy, but his head was turned by the flatteries of his friends at Vienna and Budapest. It is suggested that this may have accounted for his folly in refusing the mediation of Russia and in thus bringing about the Second Balkan War. M. Take Jonesco succeeded at the Conference in obtaining from M. Danew certain concessions in favour of Roumania, but at a later period Bulgaria would not ratify the agreement of her diplomatic representative.

The defeat of Bulgaria in the Second Balkan War, resulting in a victory for the Serbs and the invasion of Bulgaria by Roumanians, was a nasty slap in the face for Austria. It was in order to compensate herself for this check that, shortly afterwards, a campaign against Serbia was planned at Vienna; a fact subsequently made public in the Italian Chamber of Deputies. Herein lies the immediate origin of the recent world war.

A close relationship existed between Italy and Russia at this time, so that the information concerning the Austrian project was known at Petrograd. Indeed so well informed was M. Sazonoff that he had openly announced that Russia would consider an attack by Austria on Serbia a *casus belli*.

Lichnowsky states that he learnt, in the spring of 1914, from one of his officials who had been spending his leave in Vienna, that this official had been informed by Von Tschirschky, the German Ambassador at Vienna, that there would soon be war. But since Lichnowsky was kept in ignorance of important matters, he felt that there was no solid foundation for his subordinate's pessimism.

There can be little doubt now that, at the time that the Treaty of Bukharest was signed, the Ballplatz had determined to bring about a revision of its terms, well-knowing, no doubt, that the support of the Wilhelmstrasse would be forthcoming for this purpose.

A reference is made to the part played by Sir Edward Grey in December, 1913, at Lichnowsky's request, to allay the extreme irritation caused at Petrograd by the Limand von Sanders affair. The influence of the British Foreign Minister was at that time so great that he succeeded in settling the Russo-German quarrel.

Lichnowsky points out that he had succeeded in a large measure in bringing about a friendly attitude towards Germany on the part of the British public and that his efforts in this direction were loyally supported by Sir Edward Grey.

A short history is given of the Secret Treaty of 1898, entered into between Great Britain and Germany, wherein provision was made for the division of the Portuguese colonial possessions between these two Powers, in certain eventualities, and the negotiations, in relation to a second Secret Treaty, which were in progress when Lichnowsky took up his duties in London. These negotiations were continued by Lichnowsky, who expresses satisfaction at the success which attended his efforts

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to obtain valuable concessions for his country in the new Treaty; he found the British Government accommodating and ready to further German interests and wishes. A Cabinet Minister is reported to have said to the ex-Ambassador: "We don't want to grudge Germany her colonial development."

Originally, provisions relating to the Congo State were to have been included in the new Secret Treaty, whereby Germany would have obtained a right of pre-emption and the possibility of economic penetration ino this colony. Generous Germany, having regard for Belgian susceptibilities, voluntarily decided not to pursue this matter, although the British Government was ready and desirous of improving her position in Central Africa.

By May, 1913, the essential details of the new Secret Treaty had been agreed upon; an exchange of views on the subject then took place in Berlin under the presidency of the Imperial Chancellor, Lichnowsky being also present, when new demands were formulated by Germany; these Lichnowsky succeeded getting incorporated into the new Treaty, which was ready for signature in August, 1913. However, further difficulties were raised by Germany and obstacles were thrown in the way of completing the agreement by the affixing of the signatures of the parties thereto. Just before the war broke out Lichnowsky received authority definitely to complete the agreement, but the necessary signatures were never affixed thereto.

Sir Edward Grey was only willing to sign the new Treaty on condition that it should be made public, as also the Secret Treaty of 1898; but he was prepared in order to suit Germany's convenience to postpone the publication of these treaties for a period not exceeding one year from the date of affixing signatures to the new Treaty. This offer was rejected by the German Foreign Office, owing, Lichnowsky thinks to jealousy of him on the part of an individual who wished to oust him from his post in order to step into the vacancy that would thus be created.

Lichnowsky tells us that he found himself out of favour in influential quarters in the German capital; however, in June, 1914, authority was given him both to attach his signature to the Treaty and for its publication; but the peace of the world was already in danger, and, in consequence, the Treaty fell a victim to the war.

About the same period, Lichnowsky was engaged, with the assistance of von Kühlman, in negotiating with the British Foreign Office the Baghdad Treaty, which had for its object the partition of Asia Minor into spheres of influence. The most important of the concessions made in relation to this matter by Sir Edward Grey, it is stated, was the provision for the extension of the Baghdad railway to Basra. This Treaty provided for the whole of Mesopotamia, as far as Basra, being in the German sphere of influence, subject to a reservation in respect of certain British rights in relation to the navigation of the Tigris and the irrigation works of the Wilcox Company; the Germans also acquired thereby control over the regions served by the Baghdad and Anatolian railways.

Great Britain's sphere comprised the coasts of the Persian Gulf and the Smyrna-Aidin line; that of France Syria; that of Russia Armenia.

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Lichnowsky is of opinion that, if the two Treaties in question had been adopted and published, an Anglo-German alliance would have become an accomplished fact.

Lichnowsky recognizes that it was not unnatural for Great Britain, in view of Germany's position as a great military power, to feel somewhat uneasy at the effort that his country was making to become also a great naval power. He never at any time discussed the question of the German fleet with Sir Edward Grey; nor did the latter mention the proposal of the First Lord of the Admiralty relating to a "naval holiday" to the ex-Ambassador. However, it is admitted that Mr. Churchill did discuss the matter on more than one occasion, when it was explained to him by Lichnowsky why the German Government could not fall in with his proposal. Lichnowsky states that even without a "naval holiday" he could, if properly supported by the Wilhelmstrasse, have brought about an understanding between Great Britain and Germany.

Dealing with the German view that Great Britain's jealousy of Germany's commercial expansion was responsible for the war, Lichnowsky points out that, without doubt, Germany's commercial success, in the period succeeding the 1870 War, did menace the interests of British traders, who had by their industry and export houses, obtained some sort of monopoly of foreign trade. But, on the other hand, the exchange of commodities between the British Isles and Germany was continually increasing; and it was to Germany that Great Britain exported most largely. For this reason there was every desire on the part of the British traders to live on good terms with their best clients.

Lichnowsky places on record that, in his view, the Briton is a matter-of-fact individual and readily accepts the situation as he finds it; he does not tilt at windmills. It was in commercial circles that he met with the most cordial welcome and it was in those same circles that the strongest desire existed to promote the common economic interests of the two countries; whilst, in these circles, little interest seemed to be taken in the diplomatic representatives of Russia, Italy, Austria or France. The Ambassadors of Germany and the United States of America had the field to themselves.

A short description is given by Lichnowsky of the British Court and of Society. In King George he found a man of good common sense, one who, whilst acting strictly within the British Constitution, wielded considerable power and exercised a wholesome influence in his dominions.

Lichnowsky speaks of the ramifications of the House of Lords and of the House of Commons, and seems to have an idea that English Society was largely made up of the Unionist party. He states that the Englishman hankers to be in *Society!* His wish is to be a somebody, a *gentleman!* Even men of humble origin, such as Mr. Asquith, says Lichnowsky, by preference move in Society and seek the company of the upper classes. He points out that many of the members of both the old political parties belong to the same stratum of Society and have many interests in common; the only boundary between them is

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a political one and until the split on the Veto and the Home Rule questions, the members of these two parties frequently met in Society. After this split, personal relations between Unionists and Radicals became so strained that at a dinner party given by Lichnowsky, at which the King and Queen were present, the late Lord Londonderry, it is said, left the Embassy as soon as the guests had risen from the table, presumably because Sir Edward Grey was also of the party. The Englishman is summed up by the ex-Ambassador as being a person who hates *a bore*, *a schemer* and *a prig*, but who is always glad to meet *a good fellow*.

The memoirs contain appreciations of Sir Edward Grey, Mr. Asquith, Sir A. Nicholson and Sir W. Tyrrell. The ex-Ambassador formed the opinion that Sir A. Nicholson was not a friend of Germany; however, his attitude was always strictly correct. He wished to prevent the war, but when it became inevitable, he worked hard for solidarity with France. Sir W. Tyrrell was at first anti-German, but was converted, it is stated, and became a firm partisan for an *entente* with Germany.

The success which Lichnowsky met with in London did not stand him, he says, in good stead at the Wilhelmstrasse. He mentions reports of secret agents of which he had no knowledge and that he was kept completely in ignorance of all important matters; it was only towards the end of July, 1914, that he heard, by accident, from the German naval attaché of the secret Franco-British convention providing for the co-operation of the fleets of the two countries in the event of the outbreak of war.

Lichnowsky, shortly after his arrival in London, had formed the opinion that Germany had nothing to fear from Great Britain; the latter was not likely to attack her or to join in an attack begun by any other Power. On the other hand, it was evident that Great Britain would not stand by with arms crossed if France were attacked.

Towards the end of June, 1914, Lichnowsky was on a visit to his Sovereign, who was then at Kiel. Whilst he was on board the *Meteor* news was received of the assassination of the heir to the Austrian Crown. Wilhelm II. deplored the tragic end of the Archduke, since all that H.I.M. had done to win over the latter to his views was labour lost. Lichnowsky, being unaware of what was taking place in Vienna, did not attach any great importance to the Serajevo crime.

Lichnowsky proceeded from Kiel to Berlin where he saw the Imperial Chancellor and informed him that, in his opinion, Germany's relations were at that time satisfactory. Von Bethmann-Hollweg, however, did not share the ex-Ambassador's optimism. Lichnowsky also called on von Zimmermann, who informed him that Russia was about to increase her army by 900,000 men, and seemed ill-disposed towards Germany's great eastern neighbour. Nothing was, of course, said to Lichnowsky concerning von Moltke's desire to force on hostilities. However, he did learn that von Tschirschky had been rebuked for counselling the Ballplatz to treat Serbia with moderation.

On his return journey to London, from his seat in Silesia, Lichnowsky broke his journey at Berlin and was there informed that Austria proposed taking steps to put an end to the intolerable situation arising from

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Serbia's conduct. He, however, did not appreciate the importance of this information. Some time later, he learnt that at a meeting held at Potsdam on the 5th July, 1914, the draft of the Austrian ultimatum to Serbia had been approved by all the important personages present on that occasion; it had even been stated that it would not matter should the delivery of the document result in war with Russia.

Lichnowsky received instructions from the Wilhemstrasse to endeavour to win over the British Press to the cause of the Central Empires should Austria strike a blow at the "Greater Serbia" scheme. However, in view of the attitude of the British people in the past, the ex-Ambassador felt that he could not obtain the support asked for and warned his Government accordingly. The warning fell on deaf ears. The ultimatum was delivered at Belgrade and a chorus of disapproval of its terms went up at once in Great Britain. Lichnowsky gives an account of all that was done in London to avert the great conflict which was to result in the waste of so many valuable lives and so much treasure; a conflict that has brought into existence untold misery and bitterness, and is responsible also for the present labour unrest. It was recognized by Sir Edward Grey that, by pushing their claims to extremes, the Central Empires were drawing Europe into a wide-spread war; more than once he said to Lichnowsky, "It will be the greatest catastrophe the world has ever seen," and it has proved so.

Lichnowsky tells us of the hesitation that was shown by the British Cabinet in coming to a conclusion as to the course it should adopt; up to the 1st August, 1914, no definite decision on the subject had been arrived at. When it was too late for Germany to withdraw from the fatal course which she had been pursuing for years she realized that after all the Briton was by no means "decadent," but would be found standing side by side with gallant Frenchmen and Belgians ready to meet her Pomeranian Grenadiers and Prussian Guards on the fields of Northern France and in Flanders.

Lichnowsky took leave of Sir Edward Grey on the 5th August, 1914; the latter was deeply moved and expressed his willingness to act at any time as a mediator. "We don't want," he said, "to crush Germany."

The ex-Ambassador has placed it on record that the arrangements for his departure from England were befitting his station, and carried out with dignity and perfect calmness. A special train conveyed him to Harwich, where a guard of honour was furnished, the ex-Ambassador being treated as a Sovereign departing from our shores. He makes the confession that the failure of his mission was due not to the intrigues of Great Britain but to the policy pursued in his own country. Count Mensdorff saw Lichnowsky off in London, and expressed himself as satisfied; the former also let it be understood that he hoped to remain in England, attributing Great Britain's entry into the war to Germany and not to his own country.

In reviewing the work of the two years which he spent in London, Lichnowsky states that only when it was too late did he discover that he had taken up a position for which his temperament did not fit him; a position which was part of a system wherein tradition and routine reigned supreme. A system in which those who had to furnish reports

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had to be careful not to write unpleasant truths or candidly to express their own opinions on all matters coming to their knowledge.

Lichnowsky had ceased to fight against the insensate policy of the Triple Alliance ; he had recognized that his efforts in this direction were useless. He is of opinion that in spite of the mistakes made in July, 1914, peace could still have been maintained. But he had to pursue in London a policy which he felt to be a mistaken one ; its failure has, in the eyes of his own countrymen, brought discredit upon his head, for it was an offence against the Holy Ghost.

On his arrival in Berlin, Lichnowsky saw at once that he was to be made a scapegoat, although his Government had refused to accept the advice which he had frequently tendered.

An attempt was made to fix the responsibility for the war on " perfidious Albion," whose agent, Sir Edward Grey, was said to have duped the German Ambassador at the Court of St. James. Count Pourtales, however, it is that must bear a large share of the blame for the outbreak of the war. After eight years spent at Petrograd, as Germany's Ambassador, this man it was who asked the question, " What concern of Russia's is Serbia ? " The view of the Wilhelmstrasse appears to have been that the War was inevitable and must break out in 1916 at latest, for then Russia would be " ready." ; therefore, it was argued, Germany must choose her own time and bring it off in 1914.

Lichnowsky calls attention to the circumstance that there is agreement in relation to the following facts (which are not contradicted by any thing that is published in the German White Book) :—

1. Germany encouraged Court Berchtold to attack Serbia, although no German interests were involved.

2. During the critical period 23rd-30th July, 1914, although M. Sazonoff had announced in emphatic terms that Russia would not tolerate any aggressive act against Serbia, Germany refused Great Britain's offer of mediation—in spite of the acceptance by Serbia of practically the whole of the demands in Austria's ultimatum, thanks to the good offices of Great Britain and Russia.

3. On the 30th July, 1914, when Count Berchtold showed a disposition to relent, although Austria had not then been attacked, Germany sent an ultimatum to Russia and followed this up next day by a declaration of war.

In the face of these irrefutable statements, it is not surprising, says Lichnowsky, that the whole civilized world places the responsibility for the war on Germany's shoulders.

The ex-Ambassador also places on record his opinion that, under all these circumstances, it is but natural that the enemies of his country should have come to a determination to destroy the system which had become a permanent danger to Europe. A Germany dominated by the spirit of a Treitsche or a Bernhardi, ruled by feudal lords and Prussian militarism, it is admitted could not be an acceptable neighbour to the enlightened nations of the West.

Germany had continued to allow herself to be governed by the " dead hand." In their determination to bring about a change in the situation, the highest aim of Germany's enemies has been to bring

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about her democratization; their purpose, says Lichnowsky, will be realised.

An outline of Bismarck's activities are set out by Lichnowsky, who tells us that the Iron Chancellor loved a fight for the sake of fighting but planned to avoid new wars, recognizing their futility. He generally contented himself in engaging in battles wherein there was no effusion of blood. Having rapidly disposed of the Danes, Austrians, and the French, he then picked quarrels in succession with von Arnim, Pius IX. and Queen Augusta. Not satisfied with accomplishing this much, he next turned on Gortchakoff and found himself within an ace of war: it was this experience that caused Bismarck to bring into existence the Triple Alliance. Finally, he challenged Wilhelm II. and was knocked out of the ring by the then young monarch.

In spite of his quarrelsome nature, Bismarck always took care to avoid a rupture with Great Britain. He held Queen Victoria in high esteem, although he hated her daughter, the Princess Royal; he paid court to both Beaconsfield and to Salisbury, and even Gladstone had nothing to complain of regarding the Iron Chancellor.

The ultimatum to Serbia was the crowning folly to the policy inaugurated at the Congress of Berlin; such is Lichnowsky's view.

When Lichnowsky sat down to write his memoirs the war had lasted two years; he makes the admission that at that date Germany no longer expected to win an *absolute* victory against the Russians, British, French, Italians, Roumanians, and Americans, but he still clung to the hope that there might be a "stale" mate. He recognized that a *peace by compromise* would involve the evacuation of the occupied territories; he felt that advantages would accrue to Germany from such an evacuation, as she would thereby be relieved of a heavy burden and of the anxiety of another war.

Lichnowsky accepts the dictum that "Germany's future is on the sea"; but Germany's future, he says, is neither in Poland nor in Belgium, nor in France, nor in Serbia. To seek fields of activity in these regions would be to re-establish the Holy Roman Empire, to fall into the mistakes of the Hohenstaufens and the Hapsburgs. That would be the adoption of the policy of the Plantagenets, and not that of a Drake and a Raleigh, of a Nelson and a Rhodes.

The policy of the Triple Alliance, in Lichnowsky's view, meant a retrograde step; it meant turning one's back on the future. The Mitteleuropa scheme belonged to the Middle Ages. The Berlin-Baghdad railway led to a blind-alley; it was not the road leading to freedom, to infinite possibilities, to fields wherein lay the historic mission of the German people.

Lichnowsky protests that he is not the enemy of Austria, nor of Hungary, nor of Italy, nor of Serbia, nor of any other State; but he is an opponent of the policy of the Triple Alliance.

The result of the great conflict, Lichnowsky conjectures, will be that the United States of Africa will be British, as are the United States of America, those of Australia, those of Oceania; the Latin States of Europe will occupy a position in relation to the United Kingdom similar to that of the Latin States of South America to the United States of

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America—they will be dominated by the Anglo-Saxon. France, exhausted by the war, will make her alliance with Great Britain closer. Spain will follow suit.

In Asia, the Russians and Japanese will continue to expand territorally and to spread their civilization ; the British will maintain their position in Southern Asia.

The world will belong to the Anglo-Saxons, the Russians, and the Japanese ; Germany will remain in isolation with Austria-Hungary. Germany will have to confine herself to intellectual pursuits and to commerce ; power will no longer be wielded in her affairs by bureaucrats and soldiers. She arrived too late on the scene to share world power ; this disadvantage might have been overcome could she have founded a Colonial Empire ; but, with the advent of the World War, the possibility of accomplising this task has vanished for ever.

The welfare of humanity will, in the time to come, be safeguarded by the expansion of Britain's power, by Anglo-Saxon Imperialism ; such is the final declaration of Lichnowsky.

Dr. Muehlon's Memorandum.

Dr. Muehlon's memorandum was written in 1917 ; he informs us that in the middle of July, 1914, he had, as was often the case, an interview with Dr. Helfferich, then a Director of the *Deutsche Bank*. The *Deutsche Bank* had taken up a hostile attitude in relation to certain large transactions in Bulgaria and Turkey in which Krupp's were interested commercially. The future Imperial Chancellor, on the occasion of this interview, informed Dr. Muehlon that, the political situation being critical, the *Deutsche Bank* had to act with caution and was not willing to increase its commitments in foreign countries. Further, that, in eight days time, Vienna would be addressing an ultimatum to Serbia imposing exceedingly stringent conditions. A refusal on the latter's part to give immediate satisfaction in respect of the demands to be made upon her would, Dr. Helfferich stated, be followed by a declaration of war by Austria.

Dr. Helfferich, at the same time, informed Dr. Muehlon that the Kaiser had expressed himself strongly in favour of the course proposed to be taken by Vienna; and had declared that a conflict between Austria-Hungary and Serbia was a matter of domestic concern to these countries alone and he would not permit any other Power to interfere. If Russia mobilized, he also would mobilize. A German mobilization would mean immediate war. The Austrians, it is stated, were not altogether satisfied with the extremely bellicose attitude of Wilhelm II.

Dr. Muehlon then told Dr. Helfferich that the ominous information imparted to him confirmed his worst fears and made him absolutely certain that the long-talked of World War was about to begin. Dr. Helfferich, whilst agreeing with Dr. Muehlon, expressed the opinion that Russia and France might yet think it wise to accept the situation without coming to blows. Serbia, he stated, had to be taught a lesson.

Dr. Muehlon was aware that Dr. Helfferich was in a position to be well-informed as to what was taking place in official quarters, so that,

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on his return to Essen, he reported to Herr Krupp von Bohlen und Halbach what he had learnt at Berlin. Von Bohlen seemed to be astonished that Dr. Helfferich should have given the information in question to Dr. Muehlon and made a disparaging remark concerning the want of discretion shown by members of the Government. Von Bohlen then stated that he had himself recently seen the Kaiser from whom he had learnt the same information as that conveyed to him by Dr. Muehlon, but, being under the impression that it was a great secret, he had not communicated the same to Krupp's Board of Directors.

Dr. Muehlon was in Berlin on the day that the terms of the ultimatum to Serbia were made public—the predicted day—and had occasion again to interview Dr. Helfferich. At this interview Dr. Muehlon did not hesitate to say that, in his opinion, the terms of the ultimatum were monstrous; Dr. Helfferich explained that the expressions used in the German translation made the ultimatum appear more harsh than was the case in the French text of the original document. Dr. Helfferich also vouchsafed the information that the Kaiser had gone on his trip to the Norwegian Fjords for appearance sake, and, further, that the *Deutsche Bank* had taken the necessary precautions to meet all eventualities: *e.g.*, gold was being withdrawn from circulation.

Dr. Muehlon comments severely on the untruthfulness of the statements that have appeared in the German press declaring that the German Government was ignorant of the terms of the Austrian ultimatum sent to Serbia. Von Bohlen seems to have recognized that the course adopted by Germany must bring discredit upon her, since it was not likely that she could have given another Power, Austria-Hungary, full liberty of action in a situation affecting the peace of the whole world.

Von Bohlen tackled von Jagow on this matter; the latter denied that he had had anything to do in the preparation of the ultimatum, but admitted that the document did come into his hands before despatch to Serbia; it was, however, then too late for him to take any diplomatic action, owing to the Kaiser having already personally committed himself regarding the terms of the ultimatum.

Copies of two letters written on April 27th, 1918, and May 2nd, 1918 by Dr. Muehlon to the *Journal de Genève* are also published in the volume under notice; in the first of these letters he deals with the violation of the neutrality of Belgium by Germany. It is pointed out that the question of the violation of the neutrality of Belgium and also of Holland had been often discussed before the war. The only matter which the German military authorities attempted to keep secret was their plan of campaign providing for operations to begin simultaneously on the two fronts, West and East, a plan having for its object the crushing of France before Russia was ready, so that the whole strength of Germany might later be exerted against the giant Power of the East. Time was the essence of the plan, and Belgium had accordingly to suffer.

Dr. Muehlon takes up the cudgels on behalf of Belgium and tells us that he has spoken to many men in Germany, well-informed in relation to official matters, but not one of them has ever accused Belgium of

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having acted in any way improperly ; the charges against her of having entered into a conspiracy with France and Great Britain were levelled against her by paid agents of Germany in order to discredit her.

In this letter it is stated that before the war, Belgium had placed an order for four large guns (11-in.) with Krupps, of Essen, intended for the Antwerp defences. These guns were ready at the beginning of 1914, passed for acceptance, paid for and ready to be despatched ; but the defence works in which they were to be mounted had not been completed. In consequence, the Belgian Goverment asked Krupp to hold these guns for it temporarily ; the firm agreed to do so, but with reluctance. The Belgian Government was written to on several occasions and requested to remove these guns, but it always replied asking that Krupp should store them and even offered to pay any necessary expenses for their storage. When war broke out the Prussian Minister of War claimed these guns (value, £160,000) and took them over as booty.

Dr. Muehlon points out that if the Belgian Government had borne any ill-will to Germany, or had even expected a German invasion, it is improbable that it would have ordered artillery material in Germany ; at all events, it would never have been so foolish as to allow guns, which it had paid for, to remain in that country. Further, just before the outbreak of hostilities, the Belgian Government had entered into an important contract with Krupp for the supply of a new type of ammunition for field guns. The Krupp house arranged, with the consent of the Belgian Government, that Cockerill, of Seraing, should act as its sub-contractor for carrying out this contract. Had the Cockerill firm and the Belgian War Minister expected that war was imminent, as it actually proved to be, it is absolutely impossible to conceive that a contract of such importance would have been let to the chief armament firm in Germany. The above facts provide convincing evidence that Belgium is innocent of the charges, which impute a violation by her Government of her obligations as a Neutral Power, laid against her by Germany.

In the second of the two letters, Dr. Muehlon points out that Germany was guilty of two serious political blunders ; firstly, in that she took up the attitude that Austria-Hungary ought to be allowed to punish Serbia without a third Power being in any way permitted to interfere. And secondly, in that she decided that a mobilization in Russia should be immediately followed by a declaration of war by Germany.

Dr. Muehlon is of opinion that the ex-Kaiser was personally responsible for the wrong turnings that German policy took in both these matters. He considers that, although there are many to blame for the Great War, the real culprits are few in number and to be found in high places in Berlin and Vienna.

The 155th number of this series is entitled *Les Combats de Steenstraat (Avril-Mai* 1915) and is from the pen of Commandant Willy Breton, of the Belgian Army. The narrative is divided into six chapters, which are illustrated by nine sketch maps.

Chapter I. deals with the general situation in Flanders in April, 1915. The first part of the chapter briefly describes the situation

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immediately after the Battle of the Yser had been fought. The check which the Germans met with at the Yser and at Ypres having brought the First Battle of Flanders to end, there was a lull along the whole front in Belgium. A continuous trench system had by then been established from the North Sea to the Vosges Mountains. The superhuman efforts of the Entente Armies—the British, French, and Belgian, during the gigantic battles of October and November, 1914, had brought the German push on Calais to a halt, but at the conclusion of the fighting both sides were equally exhausted. It was therefore necessary for both belligerent groups to set about reorganizing their forces and consolidating the positions taken up by them. The advent of winter, by transforming Flanders into a sea of mud, rendered all major operations impossible and thus brought about a cessation of active hostilities. Advantage was taken of the truce by both sides to form new units and to provide themselves with war material of those kinds, a lack of which had hitherto much handicapped them.

The Belgian Army found itself faced with a prodigious task. After the great Battle of the Yser, following on two and a half months of incessant fighting with an enemy superior in numbers and equipment, the Belgian troops were literally at their last gasp; they had suffered so severely that only about 60,000 combatants still remained in the ranks—of these 32,000 were infantry. Many regiments had no more than a dozen officers and a very reduced number of N.C.O's. left. About half the guns, machine-guns, and rifles were for a time useless, and the stocks of ammunition were dangerously low. The supply and ordnance services were much disorganized by reason of the hasty withdrawal from Antwerp. Everything had to be re-fashioned on foreign soil—magazines, workshops and arsenals. However, all obstacles were surmounted by degrees and deficiencies were made good.

The Belgian troops quickly recovered their *morale* and set about with courage and energy to put the Yser region into a thorough state of defence; they succeeded in erecting a formidable defensive barrier under most trying climatic conditions and under the harassing fire of the invaders. When the Flanders front was divided between the Allied armies, the Belgians, in spite of their reduced numbers, became responsible for some 12 miles of this front—Nieuport to Knocke. At first, some French troops were dovetailed into this sector, but they were withdrawn as soon as the Belgian defence arrangements were completed.

The Belgian Army increased in numbers, so that in January, 1915, the front held by it was extended to the celebrated Maison du Passeur on its right, thus adding about another four miles to the length of the line held by it. In March, 1915, the Belgian front was further extended on the north of Steenstraat, making its total length about 18 miles. In a second part of this chapter, we are told that the main position held by the Belgian Army in April, 1915, was practically the same as that in which it had held its own during the Battle of the Yser. On its left a French force held a bridgehead at Nieuport, closing the road to Dunkirk along the coast. The Belgian front lay along the Nieuport-Dixmude railway from the W. of Stuyvekenskerke to a point N. of

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Steenstraat—the position is marked on a sketch map accompanying the text of the volume under notice.

Towards the end of April, 1915, the Belgian Army consisted of six infantry divisions, two cavalry divisions and some Corps troops. A Belgian artillery regiment had at this time been placed under F. M. French and some labour companies had been attached to French and British formations in Belgium.

The Belgian Army was well in hand and had recovered its *élan* in spite of its terrible experiences in 1914; its strength was being continually increased by the trained recruits joining it from the camps of instruction and by the new batteries of artillery which were being raised. Its armament and equipment were being continually improved.

Although the Belgian troops had worked hard during the winter strengthening the defence works, which had been thrown up when the line was first occupied, the positions held were still far from strong. The German bombardment did a considerable amount of damage to the Belgian defences and caused considerable inconvenience to the defenders.

In Chapter II. an account is given of the events preceding the attack on Steenstraat. The German plans are discussed in the first part of this chapter. The sudden attack launched by the Germans on April 22, 1915, after the heavy discharge of asphyxiating gas against the front Steenstraat-Langemarck, marks the beginning of the second battle of Ypres. The events which preceded this attack did not indicate that the enemy was about to undertake any important operations.

It is probable that the Germans hoped that the surprise effect produced by the nefarious and diabolical use of gas against the French front, where it connected up with Belgian front on the W. and the British front on the E., would enable them to break through the Allied line at its weakest point and on a sufficiently wide front to place the Ypres Salient in extreme jeopardy. It is possible also that the Germans attacked in order to forestall an Allied offensive in Flanders; they could not be blind to the fact that the serious checks sustained by them in October and November, 1914, had enormously raised the *morale* of the Allied troops.

The effective counter-measures of the French and the loyal assistance afforded them by the Belgian troops prevented the Germans from reaping any permanent advantage from their gas attack. The British troops also played a heroic part and their incessant counter-attacks saved the Ypres Salient.

A brief account is given in a second part to this chapter of the situation in the sector held by the Belgian 6th Division and the position of affairs at midday of April 22 is shown in a sketch map. It was fortunate that the Belgians were able to hold on to this sector, in spite of the incompleteness of their defence works. Had the Germans penetrated the front held by the 6th Division, the safety of the whole Belgian Army would have been imperilled.

In Chapter III. the story is told of the German gas attack which led to the loss of the bridgehead at Steenstraat by the French and their withdrawal to the west of the canal. The first part of the chapter deals with the events of April 22; the measures taken by General De

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Ceuninck to meet the situation are described therein. He realized the importance of retaining the positions, N.W. of Streenstraat held by the Belgian 6th Division ; the right flank of this Division was in consequence gradually reinforced by moving troops southwards from other parts of the front until eventually, at nightfall, a defensive crochet was formed N. of Lizerne.

In a second part to this Chapter, the events of April 23 are briefly described. During the night of 22—23 April the enemy was very active. A little after midnight General Wielemans, the Belgian Chief of the Staff, got into communication with General De Ceuninck and confirmed the information that the counter-attack of the Allies would be launched at 4.30 a.m., and stated that the French had requested the Belgians to co-operate therein.

Fighting began early in the morning and continued late into the evening of the 23rd *idem*. The defensive crochet N. of Lizerne was strengthened and the Belgians succeeded in connecting up with the French forces on their right at Lizerne (held by French territorials).

Chapter IV. deals with the loss of Lizerne. In the first part of this chapter an account is given of the events of the 24th *idem*. Very early on the morning of this day, the Belgians were surprised to find themselves under fire from the outskirts of Lizerne, which they imagined to be still held by the French. Patrols were sent forward and they reported that Lizerne was in the hands of the enemy and that the French trenches had been vacated. The Belgian right was now attacked in force by Germans, who advanced northwards from Lizerne and suffered heavy losses. The Germans attempted to turn the right flank of the Belgian crochet, and severe hand-to-hand fighting took place. The French delivered a splendid counter-attack during the afternoon of this day against Lizerne and Steenstraat, but at nightfall the Germans still remained in possession of these two places. During their attacks against the Belgian right the Germans again made use of gas.

In a second part to this chapter, an account is given of the operations of the 25th *idem*, which resulted in checking the further advance of the Germans.

Chapter V. contains an account of the operations which ended in the recapture of Lizerne. The first part of the chapter deals with the Franco-Belgian attacks on Lizerne ; in consequence, the Allies succeeded in closing in on the N. and S. of this hamlet. In a second part to the chapter, the story is told of how the Germans were driven out of Lizerne.

In Chapter VI. an account is given of the attack on Steenstraat which resulted in the Germans being thrown back to the E. bank of the Canal. In the first part of the chapter, a description is given of the heavy fighting in which the French were engaged from the 28th to 30th *idem ;* when the Germans put up a stubborn resistance. A second part of this chapter deals with the last phase of these operations which, lasting from the 1st to 5th May, ended in a Franco-Belgian victory whereby the Germans lost the footing that they had gained W. of the Canal.

In conclusion, Commandant Breton points out that the Germans, from a strategic point of view, gained nothing substantial by these operations, in spite of their heavy sacrifices. On the other hand, by introducing

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the use of asphyxiating gas for the first time in the war, the Germans added one more to the infamies for which they will remain notorious and execrated so long as the world lasts.

"Steenstraat" will ever be memorable in the military annals of Belgium; to commemorate the glorious part the Belgian troops played in this region during the period of the war described in the pages of the volume under notice, King Albert has granted the Grenadiers and the 3rd Infantry of the Line, regiments which bore the brunt of the fighting during the trying days of April and May, 1915, the distinction of bearing *Steenstraat* in letters of gold on their Colours.

W. A. J. O'MEARA.

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NOTICE OF MAGAZINE.

REVUE MILITAIRE SUISSE.

No. 1.—January, 1919.

THE RAISING OF A NEW ARMY IN THE UNITED STATES OF AMERICA.

The author of the original article is M. George Nestler Tricoche; he points out that, in order properly to understand the part played by America on the Western Front, it is necessary to examine the steps taken in 1917 to raise her New Army.

General Organization.—During the War, matters affecting the military forces of the United States of America have been regulated by two principal laws:—(*a*) the Law of 3rd June, 1916; and (*b*) the Emergency Law of 18th May, 1917, which authorized conscription.

In theory all American citizens between the ages of 18 and 44 inclusive, who are medically fit, are liable to serve in the American Army; this liability is expressly referred to in several enactments and particularly in the Law of 22nd April, 1898.

In practice, the American Army consists of:—

(i.). *The Regular Army* recruited on a seven-year's engagement, (three years with the Colours and four years in the Reserve), by voluntary enlistment of men between the ages of 18 and 35 years.

(ii.). *The National Guard* of the several States and territories recruited on a six-year's engagement (three years with the Colours and three years in the Reserve), by voluntary enlistment of men between the ages of 18 and 64 years (the upper age limit applies to officers only).

(iii.). *The National Army* (*i.e., the New Army*) raised, for the duration of the war, by conscription of men between the ages of 20 and 30 years inclusive, who do not belong to the two preceding categories or to the Navy.

The organization of the Reserves of the American Army is somewhat complex; they consist of the following categories:—

(1). *Reserves of the Regular Army.*—All men who have enlisted in the Regular Army and are under 45 years of age automatically fall into this category on completion of their colour service for the remaining term of their engagement. The men of the enlisted *Reserve Corps* also belong to this category; these men are specialists, between the ages of 18 and 45 years, who engage to serve for 4 years in the Reserve; they consist of engineers, electricians, hospital attendants, bakers, etc.

(2). *Reserves of the National Guard.*—All men who have served in the National Guard are, on completion of their colour service, transferred to this category for the remaining term of their engagement. Men are also directly enlisted into this category.

(3). *Reserve Training Battalions of the National Guard.*—The men composing this category are in theory the reservists in the depôts of

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the National Guard formed for training the recruits to be drafted into the active units.

ESTABLISHMENT.—*Regular Army*.—The Law of 1916 provided that in the course of five years the peace establishment of the American Army should be raised to 175,000. War was declared on Germany by the United States of America on the 6th April, 1917; at this date the number of men serving in the Army fell far short of the eventual establishment authorized by the Law of 1916. On the 6th May, the President of the Republic decided to place the Regular Army on a war footing, with an establishment of 293,000 men, increased shortly afterwards to 300,000 men.

National Guard.—In May, 1917, only 123,605 men were serving in the National Guard; it was decided to increase this force to 450,000 men by voluntary enlistment. In addition 24,700 men were to be enlisted in a *Naval Militia*.

National Army.—*The Emergency Law* provided for raising two contingents of half a million men each. About 680,000 men had been called up by the 1st January, 1918, under this law. The many circumstances under which exemptions from military service could be claimed rendered the introduction of conscription somewhat complicated in America; the details of the method adopted for obtaining recruits under the Emergency Law are set out in the original article.

COMPONENT PARTS OF THE ARMY.—*Regular Army*.—When America declared war against Germany her Regular Army consisted of:—

4 Infantry Divisions for general service.
2 Cavalry Divisions.
1 Infantry Division in the Philippines.
Troops for the Panama Canal zone.
Coast Artillery.
Auxiliary services.

In August 1917, in view of the experiences of the war, it was decided to reorganize the Infantry Divisions, the European model being adopted, and to raise their number (exclusive of the Division serving in the Philippines) to 25 (numbered 1 to 25).

Note.—Each infantry Division, as reorganized, consisted of 2 Brigades numbered from 1 to 50) of 2 regiments each (numbered 1 to 100).

National Guard.—At the date of the declaration of war, the National Guard consisted of 16 Infantry Divisions, Coast Artillery and Auxiliary services.

In August, 1917, the number of Infantry Divisions was raised to 50 (numbered from 26 to 75).

Note.—The Brigades were numbered from 51 to 150; the regiments from 101 to 300. A part of the Coast Artillery was utilized in forming divisional trench mortar batteries.

National Army.—The paper organization of the New Army was at first as follows:—

16 Infantry Divisions.
2 Cavalry Divisions.
Divisional Services.
Army Troops.
Coast Artillery.

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In connection with the reorganization carried out in August, 1917, when an increase to the New Army was made, the new Infantry Divisions were numbered from 76 to 91 ; the new Brigades from 151 to 182 ; and the new regiments from 301 to 364.

The composition of the various formations, as authorized by the Law of 1916, is fully set out in the original article.

The total strength of the American Army was on the 31st March, 1918, as follows :—

Regular Army (number of Divisions kept secret)	300,000 men.
National Guard (17 Divisions)	450,000 men.
National Army (first levée : 16 Divisions and various other units)	687,000 men.
Marine Infantry	30,000 men.
Grand total	1,467,000 men.

The very extraordinary nature of the Great War is well exemplified by the character of the special engineer, and supply and transport units, details concerning which are given in the original article, raised in America. Among the engineer units were regiments, battalions and companies for " gas and flame-thrower " services, mining, water supply, engineering supplies, running workshops, surveying and printing, electric services, forestry, etc.

The supply and transport units included companies for the manufacture of ice, repair shops (for mechanical transport), fire protection services, grave-digging, etc. There were also several Stevedore Regiments.

COMPOSITION OF UNITS.—The establishments for the various branches of the American Army are given in considerable detail in the original article.

In August, 1917, the four company organization was introduced in the battalion ; the establishment of a company being fixed at 250 all ranks. The company consists of a headquarters and four platoons.

The establishment of an American regiment is now as follows :—

Regimental and Company Staffs	303	all ranks.
3 Battalions (each of 4 Companies) ...	3,078	,,
1 Supply Company	140	,,
1 Machine-gun Company	178	,,
1 Medical detachment	56	,,
Total (103 officers and 3,652 men) ...	3,755	,,

The establishments of the American Cavalry units are as follows :—

	Officers.	O.R.	Riding Horses.
Squadron	3	105	108
Group (4 Squadrons)	14	420	435
Regiment (3 groups)	59	1,520	1,541

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The field artillery is organized in regiments of two or three groups, each of three or two batteries. The coast artillery consists of 263 companies, the strength of each, exclusive of officers and specialist N.C.O.'s, being 109 other ranks. The establishment of the divisional Engineer regiments was raised in August 1917 from 1,098 to 1,666 men.

At the beginning of 1918, the communication services were provided for by the allotment of a Field Signal Battalion, divided into three companies (for telegraph, wireless, and outpost service respectively), and a supply section to each Division. The establishment of the Field Signal Battalion is 262 all ranks, 16 vehicles, 170 riding horses and 69 draught animals.

The medical services in each Infantry Division are provided for by the four Ambulance Companies and four Field Hospitals attached thereto, and consist of 949 all ranks.

Details relating to the establishments of the Quartermaster Department, the Veterinary Corps, the Ordnance Corps, and Staff Clerks are given in the original article.

The composition of the Independent Cavalry Division is as follows :—

Headquarters	150	all ranks.
3 Brigades, each of 3 regiments	14,268	,,
1 Regiment of horse artillery (6 batts.) ...	1,374	,,
1 Battalion of mounted engineers ...	387	,,
1 Battalion of mounted signallers ...	259	,,
1 Aero Squadron	173	,,
Total	16,611	all ranks.
Total including divisional train ...	18,164	all ranks.

(*Note.*—Length of Division in column of route = 16¼ miles.)

TACTICAL ORGANIZATION.—The Infantry Division, under the terms of the Law of 1916, consisted of three Infantry Brigades, each of three regiments. The establishment of a regiment was 2,020 all ranks and total strength of the infantry in a Division, 18,559 all ranks.

When the first American contingent arrived in France, it was felt that the foregoing organization was not suitable for the requirements of European warfare. The numbers of infantry regiments in a Division were too large, whilst the establishment of the regiment was too low; the divisional cavalry regiment was not wanted, whilst, at the same time, more engineers were wanted than provided in the Engineer Regiment with each Division. It was felt also that the Flying Squadron attached to the Infantry Division could be more effectively employed by grouping it with other Flying squadrons, under a special Commanding Officer. Further, the Divisional Bridging Unit was of no use during the period of trench warfare; on the other hand, the field artillery was insufficient—72 guns, and the number of machine-gun companies were too few in relation to the strength of the infantry. No trench artillery had been provided. In consequence, the organization of

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the American Division was altered, and it eventually was composed of the following units :—

Divisional Headquarters	164	all ranks.
1 Machine-Gun Battalion—4 companies ...	768	,,
2 Infantry Brigades, each of 2 regiments and a machine gun battalion (of 3 companies)	16,420	,,
1 Field artillery brigade; 3 regiments and 1 trench-mortar battery	5,068	,,
1 Field signal battalion	262	,,
1 Engineer regiment	1,666	,,
Train	2,804	,,
Total	27,152	all ranks.

In peace time the Division only existed as a paper organization and naurally there was no higher formation. When America developed her strength on the Western Front, the Divisions were grouped into Army Corps (six to each), so as to meet the requirements of a war of positions, *i.e.*, in order to provide three lines of defence. Corps Troops, consisting of artillery, telegraph battalions, etc., amounting to 30,000 men, were allotted to each Army Corps. An Army consisted of three Army Corps and varicus additional units, composing Army Troops, which alone numbered 130,000 men.

W. A. J. O'MEARA.

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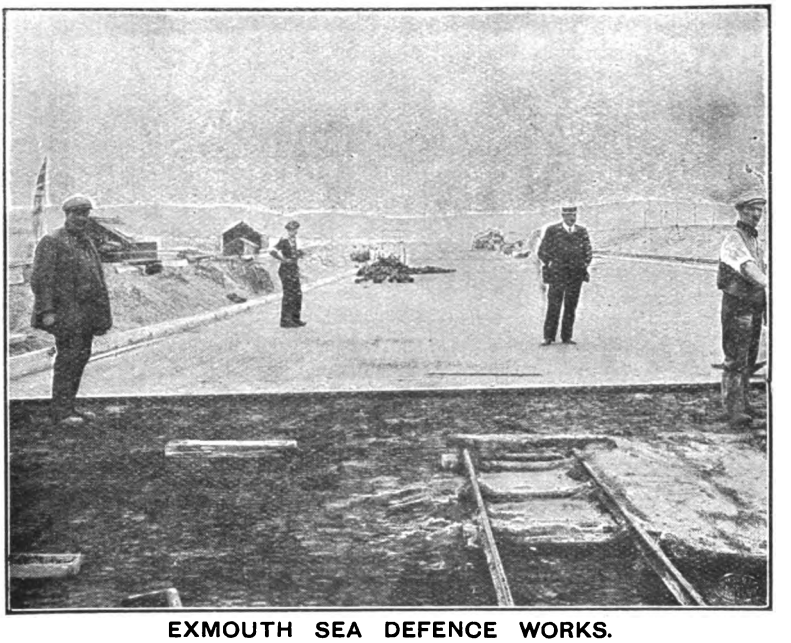

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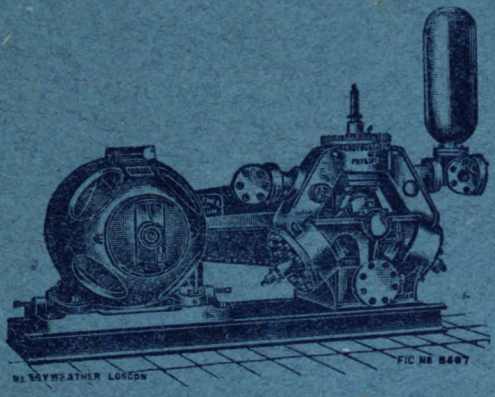

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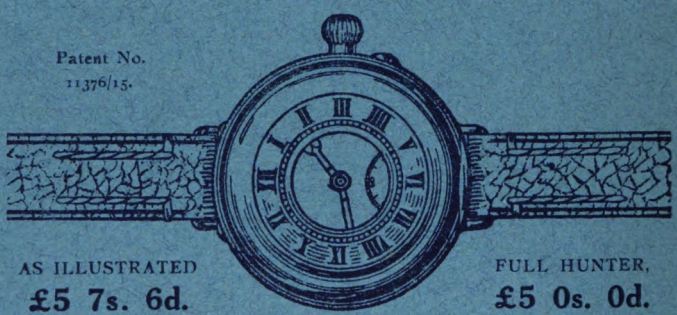

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WORK BY R.E. UNITS IN THE WAR

(*Continued from the* R.E. JOURNAL *of March*, 1919).

THE 57TH, 456TH, 458TH FIELD COMPANIES.

ON the morning of April 10th, 1918, the 57th Field Co., R.E. (O.C. Major F. N. Lund, R E.), marched to billets near the Bailleul-Armentieres railway crossing, due west of Nieppe.

About 3 p.m. the situation being very obscure, a General Officer suggested that a party should be sent out to protect our right flank. Two sections of the 57th Field Co., R.E., together with their attached infantry, deployed and advanced in a south-westerly direction and came into touch with large forces of the enemy near Menegate. Here, they engaged the enemy who was rapidly advancing and fought a rear-guard action, withdrawing slowly until they reached the railway embankment. This they held until dusk, great work being done by a Sergeant R.E., who, finding a Lewis gun and magazines, used them with great effect until all ammunition was exhausted.

The enemy now moved round to the flanks and seized the farm at the railway crossing. The party then withdrew under heavy machine-gun fire, to the main Bailleul-Armentieres road and there reported the situation to Staff Officers. Troops in the road were collected and sent out to take up the position on the railway line, which was held during the night.

On the night 12/13th April, the 458th (W.R.) Field Co., R.E., Commanded by Major E. Jackson, M.C., R.E., were in billets near Neuve Eglise, on road Neuve Eglise—Wulverghem.

The enemy attacked the village and got across the road between the R.E. and the centre of the village. On the early morning of the 13th inst., a counter-attack was organized by Major Jackson, R.E., with his Company assisted by some men of 1/4th York and Lancaster Regiment. This was very successful, the enemy battalion Commander and Staff and 16 O.R. being captured and brought in by the R.E. Major Jackson though wounded in the foot, refused to leave his company and established himself in the village. The enemy again attacked and the R.E., assisted by infantry had hard house to house fighting which ended in the company being still in the village. Major Jackson, however, was mortally wounded. The company was withdrawn by the G.O.C. Brigade.

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The captured enemy commander referred to the R.E. Company as undoubtedly picked troops and said he had never seen men fight like them, but as they were only a small body, must have been wiped out. The company was withdrawn from Neuve Eglise with the loss of one officer and eleven O.R. (mostly bullet wounds), which did not altogether bear out the enemy commander's opinion.

On 17th April, the 456th (W.R.) Field Co., R.E., O.C. Major F. A. Neill, D.S.O., R.E., formed part of a composite force holding the defences of Mont Kemmel when it was reported that the enemy were in Donegal Farm at the foot of the hill.

Lieut. A. D. Garrett, R.E., with No. 2 Section, was ordered to occupy the farm, which he did with slight opposition, establishing himself and men in the farm and two small posts outside. During the evening, the enemy apparently heavily attacked the farm and Lieut. Garrett with eight sappers were cut off therein. The two outside posts withdrew in good order, each covering the other in turn, on to the main defences. A French raiding party which entered the farm, reported an officer and his party all dead therein and surrounded by large number of dead Germans. It was not possible to recover the bodies, but only one British officer went out, and that was Lieut. Garrett, R.E.

A SPECIALLY GOOD PIECE OF R.E. WORK.

The following account may be interesting, dealing as it does with a specially good piece of R.E. work.

The enemy had made a cut in the west bank of the Haute Deule Canal. The cut itself was evidently made some time ago, as it appears on aerial photographs, but was not noticed until the night of the 10th/11th, when owing to a rise of 9 in. in the water of the canal, the water commenced to rush through the gap very rapidly.

Lieut. Peet, R.E., 157th Field Co., R.E., went out on the 11th and attempted to block the breach with sandbags. The enemy had placed a machine gun in La Ferme and swept the breach almost continuously through the night. The sappers, lying in mud all the while, attempted to block the breach, but as the level of the canal had risen another 3 in. the bags were swept out as fast as put in.

The next night another attempt was made by Lieut. Peet. A sluice box was made for the middle of the breach and this was bagged in on the sides. Owing to the heavy machine-gun fire, which killed two sappers, it was impossible to complete the job before daylight, as each sandbag had to be anchored down with a screw picket.

The next night two shifts of sappers were employed and the bagging of the sides completed. The sluice box was then closed,

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the flow of water stopped, and the box then filled in solid with sandbags. The hole was then securely banked in.

Lieut. Peet's efforts were beyond all praise, in addition he voluntarily remained back two days from going on leave in order that he might stop this breach.

The rise of water in the flooded area has now practically ceased.

F. SUMMERS, *Lieut.-Colonel, R.E.,*
C.R.E., 16th Division.

14th October, 1918.

NARRATIVE OF ACTION OF 422ND AND 423RD FIELD COMPANIES, R.E. AND PIONEERS.

On November 30th, the 422nd and 423rd Field Cos., R.E., each less one section (in reserve), and "B" and "D" Cos., Pioneers, were ordered by brigades with which they worked, to man trenches on the Brown line.

One section of 422nd Field Co., R.E., which was stationed at Villers Guislain, finding the enemy was surrounding the village from the north, retired gradually on Vaucelette Farm. Collecting a few stragglers, and being joined by a small party of infantry, this section then charged the enemy, drove him out of Gauche Wood, and recaptured a battery of 60-pounders. These they endeavoured to bring into action, but before they could do this, the party was driven back again and retired on Vaucelette Farm, which they continued to hold for the rest of the day.

One section of 422nd Field Co., R.E., stationed in Sapper Quarry, stood to in Gloster Road as soon as the alarm was given; they sustained a considerable number of casualties from shell fire, and being unsupported, were forced to fall back in the direction of Epehy. They, with some stragglers and a Lewis gun team, took up a position on a spur about 1,800 yards north-east of Epehy, whence they were able to bring effective fire to bear on the enemy. At 5.30 p.m. they established communication with the infantry who were digging in in rear of them and retired to this new line at 7 p.m.

OPERATIONS OCTOBER 20-22, 1918.—55TH, 75TH, AND 76TH FIELD COMPANIES.

The Guards Division received orders to cross the River Selle in the early morning of the 20th October, and capture the high ground east of the river.

The tasks allotted to the R.E. and 4th Bn. Coldstream Guards were as follows:—

(*a*). To construct infantry footbridges immediately before zero to pass the attacking troops over.

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(*b*). To construct two pontoon or trestle bridges as soon as possible after zero, with the primary object of crossing field guns to deal with enemy tanks.

(*c*). To construct a bridge capable of carrying all loads, including tanks, over the River Selle at St. Python.

(*d*). If considered necessary, to construct a bridge up to at least 60-pounders to relieve the traffic over the tank bridge.

(*a*) of the preceding paragraph was expected to prove the most difficult of the tasks, involving a long carry down an exposed slope from the St. Python-Haussy railway, under the close range fire of the enemy. Eight footbridges were to be made available on each brigade front, alternate bridges being duplicated if possible, and a spare pier and grid dumped at each bridge for repairs.

Two field companies (75th and 76th) were employed, one on each brigade front, each field company being assisted by one company of pioneers. The bridges used were of various types, piers of cork, petrol tins, and light barrels being utilized; all the types proved entirely satisfactory, and quite stable. Work was commenced at 22.00, tapes being laid due east from the railway to the river, and notice boards erected; this work was completed by midnight. From midnight onwards one bridge was taken down every 10 minutes on each brigade front, in accordance with a definite programme, instructions being given to erect, if possible—if not, the party was to lie down, and erect at the moment our barrage opened.

All the bridges were successfully completed before zero, the great factors being the absolute silence preserved by all ranks, the excellent organization of the field company commanders, and the avoidance of any splash as the piers were put in the water; as each bridge was completed, the party withdrew, except two sappers as a maintenance party, who sheltered under the eastern bank, and a standing patrol of two infantry at the bridgehead.

The work was not discovered by the enemy until the last bridge was being erected immediately before zero; ten rounds were fired into the party without doing any damage, but it was too late for the enemy to make any organized attempt to find out what was going on. The greatest difficulty encountered was getting the piers down the steep banks, rendered very slippery by the heavy rain, without making any noise. Ropes were fixed across the river at each crossing to enable men to pull themselves across if the bridge was smashed.

With reference to (*b*), each of the field companies employed on (*a*) was ordered to make one pontoon or trestle bridge, an attempt to be made at zero minus one hour; if this failed, work was to start when our barrage opened. 75th Field Co., on the right, got their trestles in, but one leg of one of the trestles sank in a deep

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muddy hole, and all efforts to extricate that leg or adjust the bridge failed until daylight when the bridge was quickly in working order.

The 76th Field Co., on the left, was entirely successful, using one made up trestle; a large part of the credit must be given to the carrying party of the 4th Bn. Coldstream Guards who went into the river in the dark with the trestle on their shoulders, and up-ended it in exactly the right place. This bridge was completed at zero minus 15 minutes and was used very soon after zero by Field Artillery, M.G. Limbers, etc.

The construction of the bridge to take tanks proved the most difficult of the tasks allotted to the R.E., and was entrusted to the 55th Field Co., R.E. The only approach, by which material could be got to the site of the bridge, was blocked 300 yards west of the site by a heavy brick railway bridge which had been blown down into the road; the work of clearing this obstacle was commenced at 0400; until 0800 persistent shelling, with H.E. and gas, rendered work slow; after this hour the gas shelling ceased and the men could discard their gas masks, and the rate of clearing improved. The large blocks of brickwork were broken up by explosive, and a tank did invaluable work hauling away some of the large blocks. About 1500 the first supply tank with material scrambled over the débris, and at 1700 work was actually commenced on the bridge, work being carried on under the most difficult circumstances; shelling, both H.E. and gas, was heavy up to about midnight; the darkness, and the necessity for putting on gas masks at frequent intervals, and the slippery state of the heavy timbers and R.S.Js. owing to the rain, rendered the handling of the material (one heavy trestle and two 18-ft. spans) and the placing of the trestle, matters of extreme difficulty; both R.E. and Pioneers were employed, and showed the greatest endurance and determination. The bridge was open for traffic at 0800 on the 21st. Continuous reliefs worked throughout the night on clearing the débris of the railway bridge, and a route for single traffic was through at the same time; this was widened to take double traffic within the next 24 hours.

The credit for this successful piece of work (both clearing the débris of the railway bridge, and erecting the tank bridge) belongs to the following officers:—Major H. M. S. Meares, M.C., R.E., in charge of the work, Lieut. C. J. Creed, R.E., who worked for 24 hours continuously, 2nd.-Lieut. Birch, who commanded the Supply Tanks, and 2nd-Lieut Hunter, 4th Bn. Coldstream Guards.

The bridge to take 60-pounder guns was constructed by the 75th Field Co., R.E., on the 22nd inst., work commencing at 0900 and the bridge being open for traffic at 1600; the bridge consisted of two heavy trestles, and three bays, and no difficulties were experienced except in the clearing of the débris of an iron footbridge which had originally spanned the river at the site.

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This narrative of work would not be complete without reference to the work of the R.E. patrols in connection with the operations; on two nights previous to the crossing of the River Selle, two R.E. patrols, each consisting of a R.E. officer and two men, were sent out to obtain information as to the crossings; on both nights these patrols had to fight for their information, three of the enemy being killed; the patrol leaders showed the greatest determination. On the night of the 20th October, two patrols were sent forward, one to get at the bridges in Vertain, one to reconnoitre the river Harpies; the former could not reach their objectives, but the latter brought back valuable information, in spite of the fact that the enemy was holding the eastern bank of the stream, and very much on the alert.

E. J. D. LEES, *Lt.-Col., R.E.,*
C.R.E., Guards' Division.

A SPECIAL ORDER OF THE DAY BY MAJOR-GENERAL E. P. STRICKLAND, C.B., C.M.G., D.S.O., COMMANDING 1ST DIVISION.

The task that the Division was called on to perform yesterday was one entailing the utmost forethought for every detail, the most careful and precise Staff work in all branches, a thorough and precise organisation in Bns. of the most minute detail, and gallantry, tact and endurance on the part of all troops engaged.

The complete success of the operations is very greatly due to the skill, ability, rapidity and completeness with which the bridging arrangements were completed and perfected.

I wish to pay special tribute to Lieut.-Colonel C. E. P. Sankey, D.S.O., his Field Co. Commanders, and all ranks of the D.E. and Section, 1st Australian Tunnelling Company, A.E., for the part they have played in these operations. The cool gallantry with which they placed the bridges in position under heavy fire after long and arduous hours of labour, was magnificent. After this severe ordeal they were engaged for the rest of the day in bridging under fire, without which the operations could not have been completed.

They have very worthily upheld the very high traditions of the Royal Engineers.

5th November, 1918.

REPORT ON EXAMINATION OF ENEMY TUNNEL NEAR BELLENGLISE.

With the Controller of Mines, IVth Army, we visited this tunnel at 12.30 p.m., on 30. 9. 18, and made a short examination and found it 1420 yards long with 19 entrances and five vertical shafts. There were 35 living chambers, two explosive magazines, and an engine room containing two lighting sets, and the whole tunnel was wired and fitted for electric lighting. The G.O.C., 46th Div., came into the tunnel and I asked him if he could send up the German electrician

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and engineer who had operated the plant and had been captured by the Divisional troops.

At 4 p.m. these two German prisoners and two stretcher bearers arrived under escort and I explained to them that we wanted to start up the plant and light the tunnel. I asked the German electrician if there was not a demolition circuit from the switchboard connecting up the hidden charges through the tunnel which would be detonated when the current was turned on. He said there was not, and he was well warned of what would happen to him if anything blew up, and that we would keep him down there till he had started up the plant and we had tested all the circuits on the switchboard. He then stated that there was a special circuit installed for that purpose through the whole gallery, and he consented to show us the charges. The charges consisted of cases of perdite, boxes of gun cotton, tins of picric, and 5·9 shells hidden behind the timbering and cellar walls at the entrances. The wires of the special circuit were cut and all fuses and detonators taken out and the charges removed or rendered safe. All the infantry occupying the tunnel and chambers were cleared out of the tunnel and sentries posted near entrances and the electrician started up the generating set in one hour and a half, all the circuit switches were closed and all lights put on, and since then we have kept the plant running and a party guarding them and searching for traps, mines, etc. A number of 5·9 shells were found set in behind loose timbers with nose cap against back of leg so that pressure would detonate them. Many stick grenades were lying about with the string out and the buttons hooked in the wire beds or nails so that a careless pull or lifting of the grenade would detonate them. Concealed grenades with strings and buttons sticking out.

Amount of explosives, etc., found in tunnel :—

85 boxes of perdite (4 tons).
2 ,, ,, guncotton (British).
2 ,, ,, ,, (German).
2 cases of picric.
16 5·9 shells.
21 7-in. pipe charges with fuses and tamps.
5 boxes of detonators.
4 tins ,, ,,
2 boxes of ignitors.
2 ,, ,, primers.
1 case of detonators and fuses.
1 ,, ,, electric detonators.
7 coils of fuse.

W. J. WILSON, *Major, R.E.*,
O.C., 256 Tunnelling Co., R.E.

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Capt. J. Morley Williams, who was with me throughout, has now gone over all the tunnel and declares it free from explosives, traps, &c,

3rd October, 1918.

A GAS ATTACK.

At about 4.25 a.m., 26th September, 1917, the enemy commenced to discharge gas (subsequently identified as Chloro-Picrine) in Puits 8 or 8 Bis, or both.

The distribution of *personnel* underground was at that time :—

(*a*). 1 N.C.O. and 6 other ranks, 170th Company R.E., 24 hours guard at Puits 8 and 8 Bis, 240 metre level with 2 French listeners.

(*b*). 2 French pumpmen, Puits 8, 350 metre level.

(*c*). A French shift, number unknown, working at Bure 5.

(*d*). 2 Brigade signallers, 99th Brigade repairing telephone lines.

At about 4.15 a.m. the two signallers descended Bure 5 after a short talk with the French shift, who a few minutes later, receiving word that Fosse 9 was being heavily bombarded, left at once for Fosse 9 escaping ahead of the gas though having to use their respirators. The two signallers evidently detected the gas, put on their respirators and attempted to return. One succeeded in getting away, the other only got to a point half way between Bure 5 and the turn to Fosse 4 whence his body was later recovered.

Word was received from the French mine authorities about 10 a.m. that gas was being discharged down Puits 8, which was the main downcast, and all points to which the natural ventilation would carry the gas were immediately warned. Lieut. Wood and 11 other ranks left headquarters at 10.30 a.m. with apparatus and descended Puits 9, Annequin, to discover the situation and attempt a rescue if possible. Lieut. Robertson and nine other ranks fully equipped with rescue apparatus left at 1 p.m. to assist. Lieut. Wood made four separate attempts to get through, penetrating in each case to a distance of 1,000 metres before compelled to return by the lachrymatory effect of the gas, as it was found that however closely the box respirator was fitted it was not proof against leakage in the high concentration which obtained.

Capt. Thirlwell and eight other ranks left at 6.30 p.m. to relieve Lieut. Wood's party. He succeeded in reaching Bure X and in descending this before, he had to return, owing to the same failure of the box respirator. Between 1 and 2 a.m. 27th September, 1917, the enemy shelled Fosse 9 and Fosse 4, both downcasts, with mustard shells gassing the whole of Capt. Thirlwell's party as they were

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ascending. Capt. Thirlwell and one other rank have since died and six are still in a serious condition.*

It was then decided to abandon all efforts at rescue from Fosse 9, and after consultation with the French, to work via Fosse 4 Vermelles, as by this time the gallery connecting Fosse 3 and Fosse 4 to the cross roads Z was clear of the gas which had descended during the bombardment. Capt. Brown and 11 other ranks descended Fosse 3 at 9 p.m., and found the air good to the point Z, from which station he attempted to get through to Fosse 8, as it was still hoped that the imprisoned men might be alive in some *cul-de-sac* off the main air-way. It had been noticed that the gas followed the main air-way with remarkable fidelity and was almost like a solid wall so clearly defined were its boundaries. He succeeded in getting to the head of Bure 5, a distance of 1,200 metres, before one of his party became gassed, probably due to leakage through the fabric of his face mask. This party had fixed its masks on with adhesive tape thus avoiding to a great extent the eye trouble experienced by the previous parties.

As there were no possible means of measuring the concentration of the gas, it was feared, from the trouble already experienced, that the box respirator was not sufficient protection to enable the rescue work to be carried out. The Chemical Adviser, I Corps, accordingly manufactured a new one in which the container was changeable and which was fitted with the latest German face pieces reported to be four times more impervious to infiltration of gas than the fabric in the box respirator.

The French authorities were consulted and it was decided to make use of the existing compressed air line and establish two depôts, A and B. These were to be completely enclosed canvas chambers into which compressed air at 70 lbs. pressure was fed, and then starting from the point B to make a final attempt to get through to Fosse 8 with the new respirators. Sixty hours from 12 midnight, 28th-29th, were allowed for this, after which all efforts were to be devoted to blocking Bure 5 and so saving the group of collieries connecting with Fosse 8, as should the enemy cut the tubing at the junction all these would be lost.

Lieut. Gibbons and 11 other ranks left at 10 p.m., 28·9·17, and succeeded in getting all material to the point A. Capt. Roberts and 10 other ranks left at 2 p.m. on the 28·9·17 and completed the depot at A. Lieut. Wheler, A.S. and 11 other ranks left at 7 a.m. on the 29·9·17 and completed depôt B. At 6 p.m. on the 30th, Capt. Brown and 25 other ranks left to attempt the final rescue,

* One of the men gassed in Capt. Thirlwell's party sufficiently recovered to be examined. He reports that they were not gassed whilst coming up Fosse 9. It is possible that some mustard gas was mixed with the Chloro-Picric (Lieut. Wood's party reported a diversity of tastes and smells), and that these men were all gassed by leakage through the doors while waiting to ascend.

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and descended Bure 5, discovering the body of Pte. Shanks. This showed that the imprisoned men had attempted to escape and were dead, and hence the risk of further lives in rescue work was not justified. It was then decided to test the gas and it was found that the gallery had cleared sufficiently to permit entry without the respirator for short periods.

The French miners were at once notified and it was decided to take immediate advantage of the situation to block Bure 5. Accordingly at 9 p.m., 1st October, Capt. Roberts, Capt. Brown, and 13 other ranks, with two French winchmen and a shift of French miners, descended to complete the first clay seal in Bure 5, after which our men would no longer be needed. Capt. Brown made his way along the road to Fosse 8 from the bottom of Bure 5 for about 500 yards, discovering the body of Corporal Lewis, confirming the fact that all the men were dead. Capt. Roberts tapped the compressed air line taking a branch down the shaft to the point at which work was to be carried on, assisted the French in cutting pipes, and advanced the work of sealing Bure 5 to a stage which the French were satisfied, with the presence of only two of our men to act as sentries to deal with any Germans who might be exploring. The French miners have reported that at 5 a.m., 3. 10. 17 the stopping in Bure 5 then consisted of 1·50 metres of brickwork, and our men were no longer needed.

This completely severs Fosse 8 from the mines in our area and the French miners do not consider it possible for the enemy to approach the stopping from his side and destroy it with explosives as the road leading to it is now a dead end and the ventilation difficulties would be insuperable.

It was found that respirators which had successfully withstood the test in the gas chambers leaked after a couple of hours in the heavier concentration found in the mine, and that 2,000 yards, counting in and out journeys, was the maximum distance that could be reached with them. Afterwards, when the gas had weakened, 3,000 yards counting in and out journeys, seemed to be the maximum, owing to the great strain on the lungs and heart action caused by breathing against the resistance of the container.

It is considered that from eight to ten hours is the maximum for which the box respirator could be continuously worn, for this reason, that attention ought to be directed to the necessity of relieving the pressure on the lungs by a vacuum machine, or a small clock-work fan inserted between the face piece and the container, and to relieving the exhaust valve to permit of easy exhalation. For given the requisite quantity of gas, and a favourable wind of sufficient duration, the discharge of a gas cloud lasting 24 hours is possible.

R. C. MANNING, *Major, R.E.*,
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THE TRANSITION PERIOD (IN THE WORLD-WIDE WAR OF 1914).

By LIEUT.-COLONEL ARTHUR A. CROOKSHANK, R.E.

CALL it what you like, these notes refer to defence lines built for a type of warfare which occupies an intermediate stage between rigid trench, motionless warfare or fortress fighting, and open, or motionfull warfare in which the trench has atrophied and dropped out of use altogether.

In trench fortress warfare the defences consists of a five or more line system of trenches, with innumerable cross trenches and posts or keeps. In this system the garrison remained motionless for years on end. In such a long space of time the defences naturally became highly developed (in fact, over-developed) into super-trench fortresses, the whole of the Army spending most of its time on field and civil engineering.

This type of warfare in due course, following an inexorable law, indulged in luxuries. It went in for mining, which provided complete systems of main and branch galleries, dressing stations, stores (Artillery and Engineers), living-rooms, and trench-mortar emplacements, twenty or thirty feet below ground.

Trenches became super-trenches, except as regards the obstacles in front of them and, in some cases, the drainage and cleanliness also. They were lined with timber (wainscoted or panelled) or with metal, provided with wooden floors and drains, sometimes with roofs also.

Keeps or posts were small forts for a garrison of a few men only, designed for all-round defence because as a rule the garrison had only to hold out for a few hours, knowing that they would be relieved by brigades either in reserve or resting behind the line, or by the garrison on their right or left. Operations being on a small front the line could usually be restored and made good by counter-attack.

The defences referred to in these notes are intended to be only light artillery proof, *i.e.*, to hold up the enemy, make him deploy and sit down for a bit, force him to call in the aid of his heavy artillery and to delay his advance until it arrives. In other words the defences are meant to fight a rearguard time-gaining action on a wide front and large scale. They consist of a two or three-line system with cross-trenches, parts of which, such as important high ground

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and dangerous valleys or villages, are reinforced by having more lines and more cross-trenches. A three-line system includes the provision of an advanced line of outposts, which may consist of posts only and need not be continuous. Although we are here concerned with semi-trench-fortress warfare, the subject might equally well be called semi-open warfare. We ought therefore to be thinking partly in terms of open warfare, and to be guided and influenced to some extent, by the rules of the game of "movies," or war of movement as against war of four-year old positions.

When playing the game in the open the rule is four lines; the first a line of double sentries assisted by patrols, the second a line of picquets or sentry group Headquarters, the third a line of supports, and the fourth a line of main bodies and reserves. The first three lines were manned by the outpost troops amounting to $\frac{1}{4}$ to $\frac{1}{8}$ of the whole force. The second and third lines could be each reinforced by men from the line or lines behind it. The first line was a line of observation, the duty of the garrison being to cry "I spy!" loose off a clip of ammunition and then try to beat the record, and the enemy, in the cross-country race for the second line (of picquets).

The other three lines were lines of resistance or fighting or battle lines, the greatest resistance being given on the third or fourth line; the fourth line being generally used to rally and re-form *on* and then counter-attack *from*, in order to re-take the third line and thence restore the first two lines or whole position. Consequently it would be better to use the term "four-line system" instead of "three-line."

The keeps or posts (previously referred to and hereinafter called "strong points") in these notes are not designed for all-round fire, and have no gorge defence. In this semi-open warfare, when men are surrounded, they are usually wiped out or taken prisoners; the strong points are intended to hold out while all the lines except the last, are collapsing; the final stand being made in the last line of trenches and the strong points or portions thereof. Time of construction is kept down by doing as little revetting, mining and building as possible. Breast works are avoided, but where absolutely necessary, as in lines which have to go across water-logged ground, the defence system is given two lines only; revetting in trenches is avoided by having interior slopes not too steep, and good drainage.

Mining is confined to providing underground shelters for crews of observation posts and of M.G. batteries, and in some cases for Battalion and Brigade Headquarters also. Machine guns are fought from open emplacements, the only buildings at ground level being for artillery observers.

In one respect only will these defences be superior to, and more

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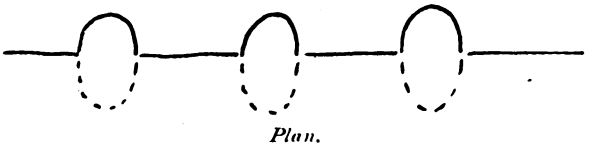
developed than, trench-fortress systems, and that is in the barbed-wire obstacles (probably also in the siting of lines and in drainage). This superiority is due to the fact that these defences are built under peace conditions instead of in the dark, under fire of snipers, machine guns and light artillery, and with frequent interruptions from other infernal machines.

As regards siting, we will suppose that it has been decided to make a defence system consisting of a continuous line of trenches between two places, either as part of a longer system continued right and left, or as a " switch," skew or diagonal system, connecting a system in front with one in rear.

Early in the war, defence systems consisted of isolated posts usually made as a ring, or all round-fire defences, round a village on high ground. The system was known as the " blob " system, or, in aggravated cases, as the " excema " design. Defences on this principle have been found to be of little use, as on a misty morning or a dark night the enemy may be able to walk straight through the system along the low ground between the " blobs. "

A continuous line made, for about the same cost, as in *Fig.* 1,



Plan.

FIG. 1.

would probably be a more efficient defensive system. When men are retiring from a position in front, or when reinforcements are coming up from behind, they must have a continuous line to be stopped on and to be organised on, otherwise they do not stop at all, but continue their straggle to the rear as a shapeless rabble.

Design of the Defence System as a Whole.—The general line of the defences having been determined for strategical or political reasons, the first thing to concentrate on is contained in one blessed word " observation," or " ground observation," without which artillery, especially light artillery, is blind and of very limited utility.

Nearly every fight since the dawn of history—in this war—has been for observation, *i.e.*, directly or indirectly for high ground or a ridge : Hill 70, Hill 63, Aubers Ridge, Vimy Ridge, Lorette Ridge, Chemin des Dames, Messines Ridge, Passchendaele Ridge, Mont Kemmel, Mont St Quentin, etc. The key of the whole enemy western front was the St. Gobain " massif."

Observation consists of two kinds, long range (for heavy artillery) and short range (for light artillery and machine guns).

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Ground Observation Posts and their Defences.—In designing, commence operations by getting hold of a layer map and marking off on it places suitable for ground observation. Then go out on the ground, taking with you, if possible, an artillery observation officer, and select the observation posts on the ground.

In every case, in this sort of work, whether for observation posts, strong points or trenches, etc., the design and selection of site must be a compromise between the map and the ground, the latter having the casting vote in case of a tie. Design on the map first, then on the ground, then back to the map, then back to the ground, and so on. These observation posts, with their protection, are the most important places in the line ; the defences must be designed so that the observation posts can be held at all costs. To get good O.Ps. it may be necessary to go out some considerable distance in front of the straight line drawn between the fixed right end and the fixed left end of the system.

The defences will then be placed well in front of these O.Ps., with possibly one trench line behind, as a reverse slope line or jumping-off line for a counter attack. The crew of the O.P., to do their work properly, should remain in peace and quiet, not worried by shells meant for trenches near by, or by the thought that a surprise raid or sudden rush of the enemy might sweep them up along with the first line or first and second lines.

The " Reverse " Slope and Forward Slope Controversy.—The expression " reverse slope " brings us on to highly debatable ground. There are two rival schools in this thorny question, the forward slopers and the back slopers, and between the two of them there have been great battles of words, both on paper and in the air. An engineer officer of high rank in an Allied army, gave *Fig.* 2, in a recent lecture,

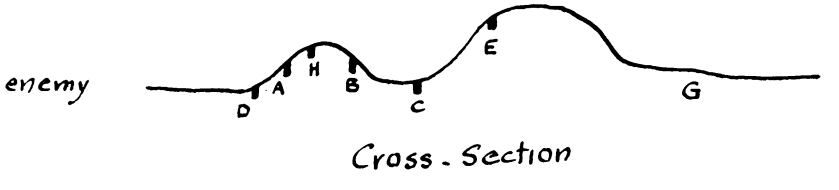

FIG. 2.

as a typical modern defence system. Forward lines at DA, back lines at BC, observation posts—forward line at H, back line at E, artillery at C and G. The only objection to this design is that there is not one bit of country in a hundred in which double-humped camels of the above kind are to be found. On this sort of ground (which is the ideal one dreams about, and which one is always looking for

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but very rarely finds), everyone would be a reverse sloper. There would be no forward slopers.

The bad half-penny rivalry between the forward and the back slope schools appears to mean that the rabid forward sloper would place his whole defence system between A and B (see *Fig.* 3), and the bigoted back sloper the whole of this between C and D.

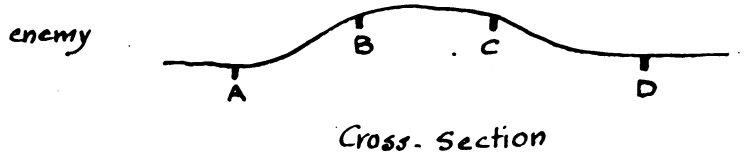

FIG. 3.

The solution of the problem is probably, as in so many other cases, a combination of the two, *i.e.*, to use the good points of both systems, keeping the centre of gravity in, or giving weight to the forward slope, so as to retain observation. It must not be forgotten that the back sloper loses the observation (*i.e.*, in one humped country). He makes the enemy a present of observation, and gives up ground to him. The enemy commands your approaches and lines of communication, while you cannot see his; the enemy can walk about in the open much as he pleases, do what he likes and see what you are doing, while you are driven to ground and forced to be very cautious. The knotty problem resolves itself into the fact that a back slope line is all right where you can get observation behind it, *e.g.*, in double-humped country where you have observation behind or over observation, *i.e.*, two lines of it, and where the loss of your forward observation line is not vital. In single-humped country, however, such as in *Fig.* 3, where you have only one observation line, the loss of that may be disastrous, because the enemy thus gets command of your approaches and L. of C., while his own are dead or invisible to you, also because, as already explained, what we are fighting for in this war is observation. In this case, the only use of a reverse slope trench—as at D, *Fig.* 3, is to enable you to re-form (on a definite continuous line) the men defeated out of your forward trenches A and B, also your reinforcements from valleys, villages, sunken-roads, woods or other existing cover in rear. It gives you a line from which to organise a counter-attack for the purpose of re-capturing your observation above and behind B, and your forward trenches at A and B, and of thus restoring your original line, *i.e.*, D is an assembly trench for a counter-offensive.

The expressions "forward slope" and "back or reverse slope" are really misnomers, because the problem can be the same in billiard-table country, *i.e.*, in country where there are no slopes at all.

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In *Figs.* 4 and 5 the conditions are the same for us, except that in 4 the difference of level is less than in 5, *i.e.*, the long-range observation is not so good, and that the belt of high trees can be destroyed by burning, and can be filled with gas.

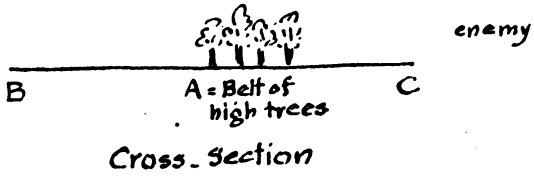

FIG. 4.

FIG. 5.

The Real Point at Issue.—The word "slope" should not be used, as it may lead one away from the real point at issue, which is to be or not to be in a position to observe the enemy's approaches; in other words, to be or not to be so placed that we prevent the enemy from seeing our approaches.

A defensive system can be said to consist of two parts or areas, the front, in which infantry predominate, and the back, in which artillery form the majority of the troops in action. In designing a defensive system one has, therefore, not the choice of two alternatives (forward or reverse slope positions), but of three, namely :—

(1) To have A (see *Figs.* 4 and 5) behind both front and back areas.

(2) In front of both.

(3) Between the two.

In case (1) the enemy sees both your areas and you see both his; in case (2) he works a few observers up to A, and then sees everything of you, you see nothing of him except his periscopes; he then directs ground observed guns on to both your areas. In case (3) he sees your front area, but not your back area—you see everything of him.

Evidently (3) is the solution of the problem. If at B there are trees or hills higher than A and commanding C, you can then have A in front of both your front and back areas, both your areas are screened, the enemy sees nothing of you, and your artillery and machine guns obtain ground observed fire over his advance.

Design of Defence System as a Whole.—To return to our muttons—when the observation posts with their defences have been determined

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on the ground, we then have a number of fixed points in our system. It only remains then to lay out the lines required to connect these fixed points. Here we may be influenced by places which it is important to protect, because we want to use them ourselves and prevent the enemy having the use of them, such bridges or portions of roads, villages or other existing cover. We may be influenced also by obstacles which it is an economy to make use of—such as rivers, canals, marshes, ponds, etc.; also by places which we want to keep the enemy out of—such as quarries, cuttings, farms, villages, woods, etc.; also by places which we want to avoid and keep clear of ourselves—such as woods and low-lying ground, because of gas and of morning mists favourable to the attack, and of the expense of breast work; roads, especially road junctions (because of artillery fire), or any other land-marks shewn on the maps, or conspicuous objects—such as windmills, chimneys, mounds, solitary trees, small copses, etc. which attract enemy fire. We may be influenced by places wanted for batteries or nests of machine guns. For these consult and work in with the machine gunners.

Generally speaking the design of the lines in the intervals between observation posts is similar to designing a cart road with a ruling gradient. When crossing spurs and valleys you go forward towards the enemy on the high ground and back on the low, in order to retain command of as much of the spur as possible; this is our old friend "observation" to prevent the enemy commanding you, and to get that very valuable asset, "cross fire" across the valley; a valley is always a source of danger and a likely line of attack for the enemy.

Design on a large scale map first, and then by give and take on the ground. Give as little ground as possible to the enemy and take as much as you can inside your own lines. Design by trial and elimination, first on the map then on the ground, in turn.

Detail Siting of Lines.—The detail siting of lines of the ground is a most important work, the success of the defence system (like the foundations of a building) depends upon it. It should only be done by properly qualified officers. They should have plenty of time to do it methodically and carefully, and should not be hustled by having working parties treading on their heels. On the other hand they should not be too far ahead of their working or spitlocking parties. The siting officers should move their trial lines backwards and forwards until they have found exactly the right place for each portion. They should then go across No Man's Land to the enemy, and look at the other side of the picture. They should act the part of enemy attacking infantry and enemy observers, advance on the trench line to see where they first come under observation and first under fire from the trench line. They should know every inch of their ground so as to be able to tell at once if their tapes

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have been moved. Cases have occurred of a trench being dug to a tape traced by a farmer, who lifted the tape, took it off his own fields, and put it down during the night on another man's fields; also of a trench being dug to a tape traced by some cows, which had dribbed the tape away from its original site; also of a trench being dug the wrong side of a tape, making the traverses about 2′ 6″ wide instead of 15′ 0″. There are few things more unsatisfactory, from a field-engineer's point of view, than to have to fill in a trench and dig another one close to it. It shakes the confidence of the working parties in the sappers and also makes the former lose heart and interest in the work.

Field of Fire.—Trenches, except those made exclusively to provide cover, or as communications, *i.e.*, fire trenches, should be sited to give the best possible field of fire for the infantryman's rifle, and should be screened from artillery ground observation if possible, by hedges, trees, etc. Sky lines should be avoided, so should long lengths of straight; the line must be in waves, or corrugated, to get cross fire, and to make it harder for the enemy's artillery. Better a hidden trench with a range of 200 or 300 yards, than an exposed trench with a range of 800 or 1000 yards. Cases have occurred of trenches with a short field of fire being much more stoutly defended than those with a long field. In the former, the defenders know that if they get out of the trench to go backwards they will be shot down at short range by the enemy, so they stick it to the close fighting or bayonet stage. With a long field of fire the defenders see the enemy continually advancing, in spite of all the ammunition they are firing off (nearly all of which is of no effect); they lose heart and retire out of their trench, which they can do with little chance of being hit by the attacking infantry at long range. Also a large proportion of fighting occurs at night, when long ranges are useless. A long range has the advantage, however, that it gives the artillery a good chance of inflicting casualties. Lines which have the enemy on top of them, *i.e.*, which are commanded by the enemy's attacking infantry, should be given a longer range, say not less than 500 yards.

Ideal Arrangement.—The ideal conditions are shown in *Fig.* 6; this is what one is always looking for but very rarely finds. The distance AB is say 300 yards, hedge B screens our trench A from enemy artillery observation; ground at C is under our observation

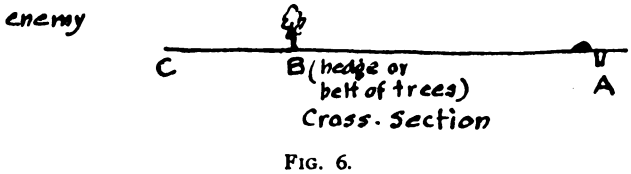

FIG. 6.

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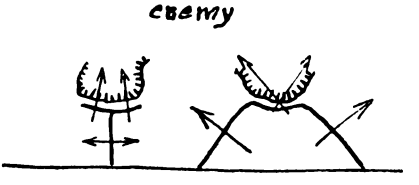
from tall trees or high ground behind A, or to one flank of it. As the enemy advances across C he comes under our ground observed artillery fire.

Dead Ground.—Small patches of dead ground (such as a quarry, pit, sunken road, steep bank or dip in the ground) in front of the general line of a trench should be commanded by a bastion if possible, if not by a tee head (see *Fig.* 7), *i.e.*, if the line itself cannot be bent forward to command them or, better still, to include them. Always site a line to have grazing fire, and avoid plunging fire as much as possible.

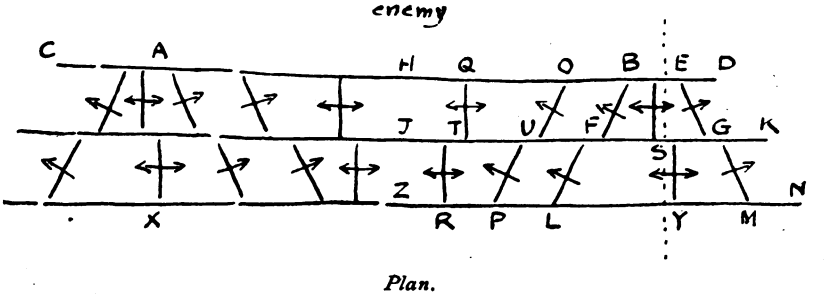


Plan.

FIG. 7.

Strong Points.—Having determined the general design of the trench system, of say three lines, more or less parallel, with an outpost line in front, then design the strong points. These are simply parts of the system which are reinforced by having more trenches and more ostacles than the rest. A strong point will of course be made round each observation post, and the remaining strong points will, if possible, be on high ground; each strong point should be able to see the one on its right, and the one on its left, so that it can visual signal to them, and also watch the progress of the fighting near them.

It is both criminal and impossible to have a standard design for a strong point. A single case, the simplest, and also about the scarcest, may however be considered. Take a three-line system in dead-flat and open marshy country (see *Fig.* 8). The lines in this,



Plan.

FIG. 8.

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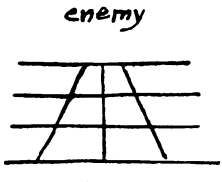
and in other plans in these notes, are shewn straight to make the drawing clearer. In actual practice they never would be, and must not be, even in bowling-green country. A strong point Y is to be placed to block or bar a road which the system crosses at right angles. Under these very rare conditions we get a symmetrical "strong point," with strong flanks BFL and EGM, no gorge defence (as already explained) and a central fighting, communication and shooting-two-ways line through SY. Each line has an anti-enfilade offset in it.

The defensive system will then, under the conditions of semi-trench warfare for which we are designing, be fought on the elastic or flexible line or bowstring system, as follows. The enemy attacks all along this portion of the line, and succeeds in gaining ground towards HJZ and DKN. He then succeeds in widening his two breaches to the right and left, but is held up by the strong points round SY and AX. The defenders will then fight on the following lines in succession :—(1) HQOBED. (2) JFBEGK. (3) ZLFBEGMN. (4) ZLFSGMN. (5) ZLYMN. They then strategically advance to the rear "according to plan" (*i.e.*, the plan of the victorious enemy). Students of fortification architecture will recognise in these lines the Vauban system, poorly camouflaged; this reversion to type is natural and excusable in a country where one is surrounded by such splendid examples of the great master's genius, and where one breathes his atmosphere.

The design of each strong point is of course, ruled, with a rod of iron, by local topographical conditions, which you will find will give you every sort of shape or mis-shape from variations on the A type *Fig.* 9, through the H type *Fig.* 10, to the V type *Fig.* 11.



Plan.

FIG. 9.

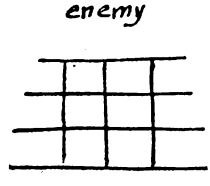


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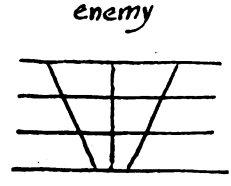
FIG. 10.



Plan.

FIG. 11.

Fig. 11 is a bad type, because it is in unstable equilibrium. The acute salients or angles at the forward corners being weak in fire, so also are the flanks. There can be no more standardization in the design of strong points than in the shape of clouds in the sky. Two points should, however, be remembered: provide a good field of fire on each flank, *i.e.*, make both flanks strong, and keep the centre of gravity back: do not get it between your first and second lines, or in the forward half of the system (as in *Fig.* 11 above).

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Obstacles for Strong Points.—As regards obstacles, the outer line PLFBEGMN, *Fig.* 8, would have a broad belt of barbed wire entanglement in front of it, and all other lines a narrow belt, the central line having a narrow belt on either side of it.

Design of Lines between Strong Points.—There now remain the portions of the system between the strong points. If the enemy's best line of advance and only chance of getting through is towards HJZ, *i.e.*, if he is obliged to attack on H, and cannot hope to do any good elsewhere, then the branch or cross lines near the strong point can be designed to be diagonal as OUP. Cross lines near HJZ should be at right angles, as QTR, firing both ways and ready to meet a penetration either side of Q. A diagonal or skew line of the type OUP is weak against an attack on O or between O and B. All the cross lines, also lines in the strong points, should of course, be waved and staggered, off-setted or stepped where they cross the mains, to make them enfilade fire-proof.

Junctions on "Hinges."—In placing these cross lines, certain features require careful and special treatment, viz. :—Villages, valleys and woods, also junctions of defensive systems, *i.e.*, places where your system crosses others, or where branch systems connect yours with other systems in front or behind. These "hinges" should be carefully worked out, so that each line of the three or four line system runs continuously through the junctions without a break. They should then be designed as strong points; in other words, junctions of systems should be sited at naturally strong points, *i.e.*, the type of strong point which is born and not made.

Villages.—As regards villages, the enemy likes getting into villages and filling the cellars and stumps of walls with machine guns. Keep him out of them by placing a line round the outside of the village, but near to it, and on the enemy side. The village is presumed to be still inhabited, and the houses and back-gardens not available for knocking about. If the village is ruined and dead, and one has a free hand and a blank cheque, reinforced concrete machine gun boxes should be built in the cellars and ruins—on a properly designed system—with over-lapping areas of fire. This system strengthens the continuous trench, which is made, as above mentioned, outside and on the enemy side of the village.

Valleys.—As regards valleys, a favourite manœuvre of the enemy was to creep up these on a misty morning by means of patrols with light machine guns, followed by light trench mortars, enfilade the trench system, and make the defenders either quit altogether or keep their heads down. A frontal attack on the trench was then an easy matter.

The valley should be provided with longitudinal trenches, forming a V with the water course, giving cross fire across the valley and its approaches; the connecting trenches giving fire straight down the

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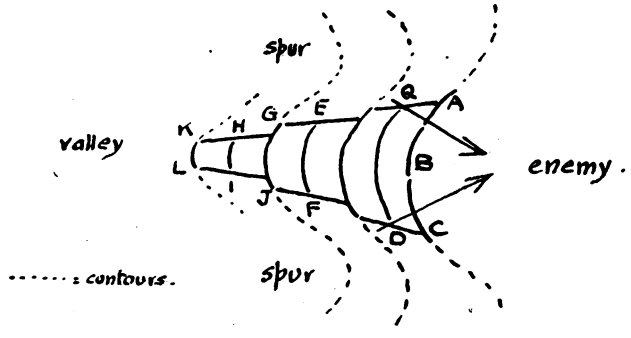
valley (see *Fig.* 12). The longitudinal trenches AK and CL should



Plan.

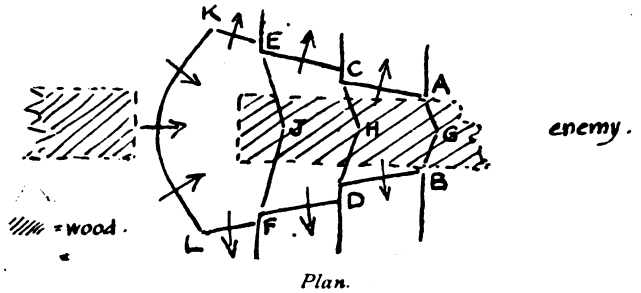
FIG. 12.

be kept low down, so as to give grazing fire along the bottom of the valley instead of plunging fire from a high level trench. A high level trench may sometimes have to be provided in addition to the low level one. In important valleys, dangerous for us and favourable for the enemy's attack, extra lines may have to be added, as—QD, EF, GK, JL, HI, and KL. The portion GKLJ sometimes comes behind the last or rear line of the system.

Woods.—As regards woods, these are unpopular nowadays because gas clings to them, and it is difficult to clear them of it. Nevertheless woods, especially forests and large woods, give an advantage to the defenders, and are an anxiety to the attackers. The defences should be designed for both cases, *i.e.*, both with and without gas in the attack.

The lines can sometimes be swung clear of woods, either in front or behind them.

If the lines have to go through a wood, make cross trenches ACE and BDF (see *Fig.* 13), and a connector EKLF through the wood



Plan.

FIG. 13.

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by a wide clearing in front of KL. Also barbed wire chevrons AG, BG, CH, DH, EJ, FJ, enfiladed by machine guns at A, B, C, D, E and F. Make trenches also along AG, BG, CH, DH, EJ, FJ, in case the enemy does not use gas. The advantage of these trenches is that they can be made air-photo proof by winding the trace about between the trees and dodging them as they stand, without cutting down anything except a narrow belt in front of the wire chevrons, just wide enough for enfilade fire. Large villages or towns require to be similarly treated.

Obstacles.—As regards natural obstacles, examine the map and, later on, the ground, for all existing obstacles, canals, streams, wet ditches, water of any sort, marshes, boggy ground, country cut up by ditches or rough ground (useful to make the enemy swear on a dark night and thus give himself away), cattle fences, etc. Use these for all you are worth, partly to save the expense of barbed wire obstacles and partly to have a variety of obstacle, and thus confuse and surprise the enemy—barbed wire entanglements get monotonous.

Design your lines fairly close along and, say, 50 to 100 yards behind these obstacles, and if the obstacle is serious enough to require bridging, such as a wide and deep canal or river, place a second line near enough behind the first to enable you to interfere with the enemy's efforts to get his guns across the water, after you have lost your first line close behind the obstacle. Any existing bridges should of course have bridge-head defences of a more or less semi-circular shape in plan.

Other Obstacles.—All bridges, road junctions, and possible observation posts, such as high buildings or isolated trees should be prepared for demolition. Dams should also be made with sluice gates ready for shutting down and flooding ditches, hollows, valleys or marshes if the flow is in the right direction, *i.e.*, from the enemy or parallel to your line. In the latter case, defences near the dam should be strengthened.

As regards barbed wire obstacles, existing cattle fences can be reinforced, hedges wired and loose wire spirals thrown into ditches and into water which must be forded, *i.e.*, is not jumpable. In some places abattis can be made of trees or big bushes.

Wire Entanglements.—In obstacle-less country one has to fall back on a barbed wire entanglement; in the latter the best part of the obstacle is the spiral. In designing, therefore, all one has to do to produce a cheap entanglement is to make a framework or support to keep the spiral in position and up to full cross-section. For this floor is necessary, also a ceiling, the spiral forming loops outside both. If the floor is omitted the bottom loops of the spiral become too low in some places, and too high up in others, thus giving the enemy "crawler" an opening.

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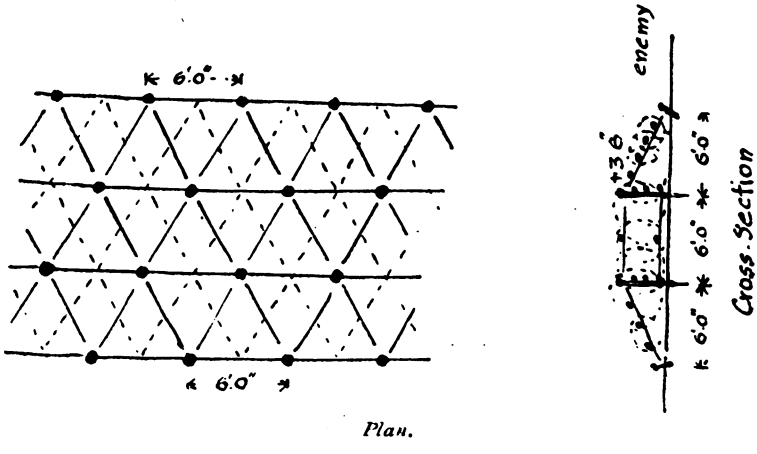
The ceiling is required to keep the spiral up to full height, otherwise it will gradually "sit down" on to the ground by its own weight and give the enemy "jumper" a chance (see *Fig.* 14). The spiral will be laid along the line shewn dotted in the plan; the ceiling and floor wires and the sloping guys to be taut, other wires fairly slack.



Plan.

FIG. 14.

If pickets or wire are scarce the spiral can be supported on an apron fence (see *Fig.* 15).

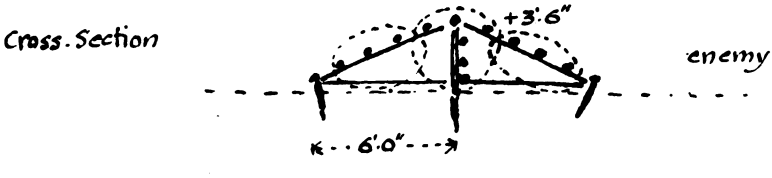


FIG. 15.

In construction the amount of wire to be used per yard run of belt should be specified, otherwise the entanglement will be too thin and inefficient in some places and too dense and expensive in others. Other points to look out for are (1) the attachment of the wires to the posts, so that they will not run down. The wires can be "tourniqueted" round or windlassed. (2) Drive the pickets well into the ground. (3) Devise a regular "drill" for the work, in order to save time and ensure uniformity.

A considerable amount of supervision is required to produce a good quality wire entanglement, indeed this work requires more skilled supervision than any other class of unskilled labour work, *i.e.*, earthwork, trenches, breastworks, dug-outs, etc., mentioned in these notes.

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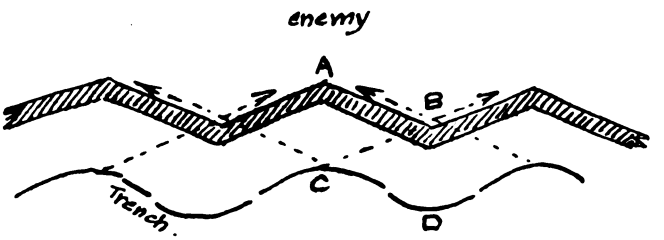
As regards trace, the entanglement should be designed in saw-tooth or chevron shape (see *Fig.* 16).

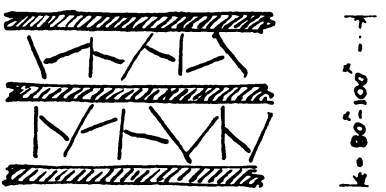


Plan.

FIG. 16.

The distance AC or BD to be not more than 150 yards, for close range rifle fire at night, or less than 50 yards, to be hand-bomb proof. The sides of the chevrons such as AB, should be sited so as to be enfiladable from the trench, but the belt should, if possible under the above conditions, not be parallel to the trench, as shewn in *Fig.* 16. The wire should, if possible, be concealed from enemy observation, but it is not worth while making excavations for wire only.

The entanglement should consist of two types, the broad consisting of three belts each belt as in (see *Fig.* 14), connected by cattle fences, making a total width of 80 to 100 yards (see *Fig.* 17).

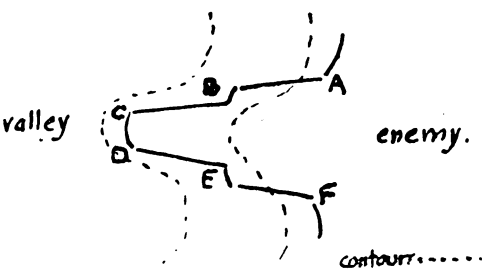


Plan.

FIG. 17.

The narrow type will consist of a single belt (as in *Fig.* 14).

The broad type will be put round the perimeter of each strong point (see *Fig.* 8), and in dangerous valleys (see *Fig.* 18)—such as ABC,



Plan.

FIG. 18.

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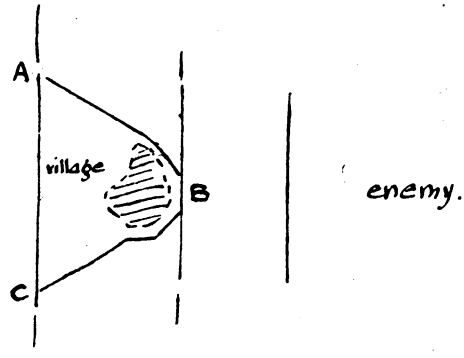
FED and CD, or round the enemy side of dangerous villages (see *Fig.* 19), as AB, BC.



Plan.

FIG. 19.

Elsewhere, the narrow type to be used. One belt should first be laid right along the system from end to end, say along the second line in a three-line system or whichever line the best fight can be put up on, and round the strong points. Other lines can then be wired as time, materials and labour permit.

Design of Trench (*plan or trace*).—The usual types of trench design in plan, are the rectangular, or Greek key pattern, (see *Fig.* 20).

Plan.

FIG. 20.

The semi-circular (see *Fig.* 21) and the Vauban—135°. (see *Fig.* 22),

Plan.

FIG. 21.

Plan.

FIG. 22.

Traverses can be placed forward of the general line or behind it, the latter is the more usual method. As regards the relative merits of the three types, the rectangular and the semi-circular have a large percentage of fireless, or useless parapet. The semi-circular, is easier than the rectangular for trench traffic, but difficult to revet to a regular curve; the 135° type has no fireless parts at all, gives, in itself, without any waving of the general line, that blessed thing

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cross fire, and is the best for trench traffic, especially for stretchers. It can also be used for breast-works. The 135° design is consequently the most efficient. Traverses should be at least 15 ft. wide.

The two traces (1) the wavy or corrugated pattern (see *Fig.* 23).

Plan.

FIG. 23.

(2) and the saw-tooth pattern (see *Fig.* 24), are useful for communication trenches, also for portions of fire trenches, where there is not a good field of fire, such as steep slopes, or where the other designs cannot be made to fit in between two fixed points without distortion or mutilation.

Plan.

FIG. 24.

In these notes the word "cost" means not only cost in cash, materials, which are often hard to get at any price, or labour, which has a nasty habit of suddenly and unexpectedly becoming scarce, but also in time. The latter is often a vital or decisive factor in war; loss of time may mean loss of men's lives, and of battles and campaigns.

Design of Trench (*cross section*).—As regards design of the cross section of trenches (see *Fig.* 25), the width of the floor of the trench

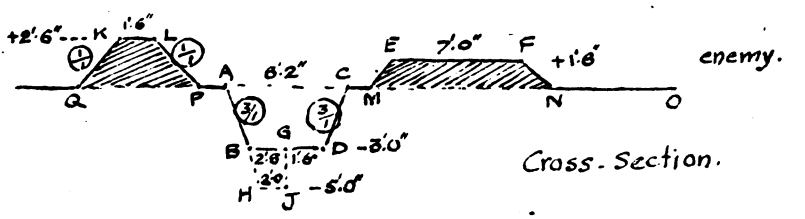

FIG. 25.

BD should be as small as possible. The slope AB or CD depends on the soil, and should be the steepest slope at which the cut earth will stand by itself, *i.e.*, its angle of repose, under heavy

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showers, if built for summer use only, and under frost plus thaw, if built for winter use.

On the average, the slopes AB and CD may be made 3/1, allowing a total cover of 6′ 6″ (to enable men to walk along without stooping). BHJG, the through-traffic part of the trench, becomes minus 5′ 0″, BG=2′ 8″ and the width of the trench at ground level AC=6′2″.

As regards the crest (or height of parapet), 1′ 6″ is better than 1′ 0″. The latter is apt to be blinded by small bumps or irregularities in the ground surface, or by long grass. The width EF should be rather more than absolute bullet-proof minimum, because the edges at E and F are apt to get worn away. The text book height of crest for fire standing=4′ 6″ is too great, 4′ 0″ or 4′ 3″ is high enough for the average British soldier.

Design of Parados (*trench cross-section*).—The design of the parados is open to discussion—whether it should be higher than the parapet, or of the same height, or lower. The advantages of making it higher than the parapet, say 1′ 0″, are :—

(1) It is an aid to concealment ; what gives away a trench is the movement of the men firing from it and their white faces, both more visible on a sky line or against a distant background than against a near background.

(2) It stops bullets which come just over the top of the parapet, and prevents them doing damage to men behind.

(3) It gives more protection against back fire from shells bursting behind the parados.

(4) The enemy cannot use the trench against you immediately after he has captured it.

(5) It enables an irregular sky line to be given to the trench without interfering with the fire capacity, as would be the case if the parapet were irregularised instead of the parados.

The disadvantages are :—

(1) It might stop and burst those few shells which come with a flat trajectory just over the top of the parapet.

(2) More concealment work is required, *e.g.*, turfing, etc., to the top of the parados, to make it less visible to enemy advancing infantry.

(3) The trench cannot be used for firing to the rear, if surrounded or the flank suddenly turned, without putting in work on it. This is, however, not a real objection, as trenches which are at all likely to be wanted for firing both ways (such as rectangular cross-trenches and interior or spinal trenches of strong points) would be designed with a double parapet to fire both ways, and two fire steps.

Construction of Trenches.—In construction the important thing is to leave the trench in a usable condition at each stage of the

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proceedings ; if it is only possible to do a little work on the first day, leave the trench fit for fire lying down or fire kneeling, and complete it to fire standing, next day. As regards tasks, unskilled labour, such as Chinese coolies, can do 220 cubic feet a day, including trimming spoil.

Work should be started by peeling a skin (of 6″ or 9″) off MN, (see *Fig.* 25), and stacking it at O. The earth, as it comes out of the excavation should be formed into the parapet. Directly the latter is finished, the skin from O should be laid over it. Crops and roots can be re-planted and saved, in this way also the excavated earth concealed. The parados is then done in the same way. Small borrow pits will be required to make up the parados, as the earth obtained out of the trench is insufficient for both parapet and parados. The passage BHJG should not be dug out unless the vertical revetment GJ can be done at the same time.

Before ground is broken at all, three templates to the shapes MEFN, QKLP and AEDC, and a pick and shovel for every man, should be on the ground. Later on a fourth template should be provided for BHJG. If a long three line system is to be built, concentrate labour on :—

(1) Getting one continuous line through from end to end.
(2) Strong points.
(3) Valleys and villages.
(4) Other lines.

The same principle applies to obstacles.

A fighting line or sorts, will then be ready along the whole front as early as possible.

Drainage.—The life of a trench varies directly with the efficiency of the drainage, which must be done at the same time as the trenches. Levels must therefore be taken and drainage designs got out before ground is broken. Cases have occurred of large and deep soak-pits being made against the fall of the ground, *i.e.*, uphill, when the bottom of the trench itself was porous, and the bottom of the soak-pit was not, thus making it into a reservoir, also when the trench, if the floor had not been porous, could have been drained out over the surface of the ground by cutting a short trench on the down-hill side of the trench. Cases have also occurred of a drain being cut in the watershed of a trench, and of a drain being made which conveyed the water from a neighbouring stream into the trench.

If the passage BHJG is not likely to be excavated for some time after ABDC, the drainage should be designed for the level of minus (5′ 0″) not forgetting to allow for the fall in the trench floor, but only dug to minus (3′ 0″). The drains could then be deepened, when BHJG is being dug.

If the floor is likely to remain as BGD for some time, a shallow

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drain BRG (see *Fig.* 26) should be made. The passage BHJG should never be dug out until material for revetting GJ is on site.

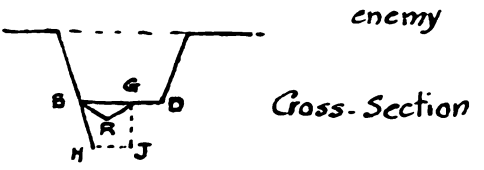


FIG. 26.

Breastworks (*Design of Defences as a whole*).—Breastwork lines are expensive both in materials and in time and should be avoided if possible. Where unavoidable the defence line should be first made to consist of detached posts about 200 yards apart, with a continuous obstacle in front (to get a fightable line, of sorts, through quickly). More posts should then be added, reducing the interval to 100 yards. The posts should be "staggered," *i.e.*, the general line should be wavy and not straight. Breastwork should only be made continuous in very important and dangerous places.

The design in *Fig.* 27 can sometimes be adopted in flat country.

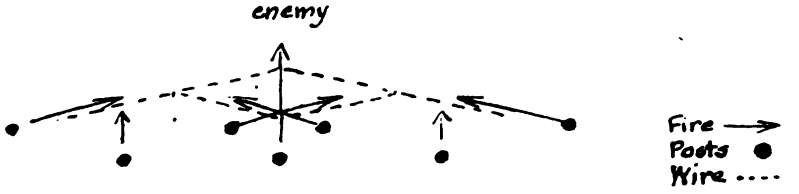
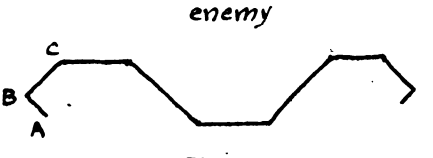


FIG. 27.

Breastwork Posts.—A breastwork post is a very conspicuous and very vulnerable object; every effort must be made to conceal it behind hedges, trees, rushes, etc., as it will not stand many hits from shells.

Design of Plan.—*Fig.* No. 28 shews a one-traverse type of post in the 135° trace style. The entrance AB should be made perpen-



Plan.

FIG. 28.

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dicular to BC to prevent casualties to men (firing from BC) by a shell bursting in prolongation of BC.

Breastwork, Design of Cross-section.—*Fig.* No. 29 shews a cheap type

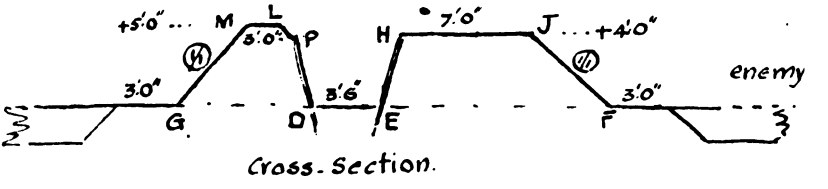

FIG. 29.

of breastwork ; the parapet is 4′ 0″ high (after allowing for settlement and weathering, *i.e.*, it is first built to 4′ 6″ or 4′ 9″) ; the exterior slopes of parapet and parados are 1/1; 1/2 is considerably more expensive ; trench floor DE is 3′ 6″ wide, *i.e.*, as narrow as possible. (Templates to be made for EHJF and DPLMG.) If the highest subsoil water level permits, a through traffic passage can be dug, the floor width DE must then be widened to 5′ 0″ (see *Fig.*30).

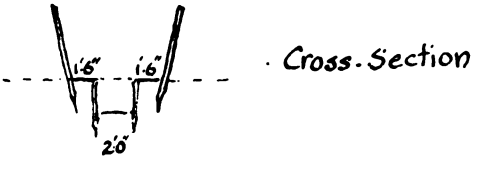

FIG. 30.

Breastwork Construction.—The borrow pits should be taped out and made wide and shallow, and the edge nearest the parados and parapet cut to a slope of 1/1, and not vertical ; the berm to be at least 3′ 0″ wide.

If the soil is damp or soft and not able to carry the pressure due to a head of 4 ft. of earth, the skin at EF and GD if of good turf should not be removed ; it is valuable as a foundation. In green surroundings HJ and JF should be sodded partly for concealment and partly as protection against weather. PLM in the parados should also be turfed, and lastly MG if sods are plentiful. LP to be bevelled off at 1/1. Thickness of parados at level of P to be 3′ 0″.

In construction the points to look out for are:—

(1) Borrow-pits—keep the berm inviolate, and do not make a hole 4′ 0″, with vertical sides at the toe of the exterior slopes of parapet and parados.

(2) If hurdle revetment is used, make it continuous hurdle work if possible, as being more flexible and elastic, and thus giving off

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fewer splinters under shell fire or other explosions. With ready-made hurdles use stout posts driven in well, as stanchions, to hold up the hurdles, in addition to the vertical withes in the hurdles. These posts to be wire-guyed top and bottom. Guys to be so adjusted that (*a*) the hurdle finishes up, after taking the load, at the correct (interior) slope with the guys taut. Each guy to be wind-lassed up separately, not two together.

(3) Anchorages for the guys are important, the holding power of the ground, with a high subsoil water level, being small, anchorages can be of 1 : 1 pickets or of sunken logs, parallel to the line of the hurdles or trench.

After a little practice breastworks of good quality can be made by unskilled labour such as Chinese.

MISCELLANEOUS.

Lengths of Straight in Trenches.—Portions of straight in trenches should be made :—

(1) In cross trenches where they cross main lines, on the enemy side of the latter.

(2) Where a trench enters a strong point, *i.e.*, just outside the latter on the enemy side and on the flanks of the strong point's perimeter.

(3) Occasionally in main lines to prevent the enemy working his way along, such as when widening a breach or penetration of the system.

Passages through Lines.—Gaps should be made through wire for artillery, and, between these artillery-gaps, others for infantry ; they should be marked by posts at least 6′ 0″ above ground, so that they can be quickly picked up from a distance. A pole with a white cross or X on top is a very efficient sign.

Ways for artillery should be made across the lines—in the case of trenches, either by not digging the trench, or by cutting ramps down to the floor of the trench, or by portable trench bridges. Steps or ramps should also be made to enable infantry to get out of the trench quickly. Gaps should be left similarly in breastworks.

Notice Boards.—Notice boards should be liberally provided, showing trenches, with nicknames and defence names, *e.g.*, Dunkirk to Basle Defences, Champagne Sector Reserve Line, Jazz Trench, O.Ps., M.G. emplacements, dug-out entrances, artillery positions, etc. Strong points should have a map, painted on a large board, of the S.P. and trenches round it.

Buildings, Above-ground and Under-ground.—Although we are dealing with semi-trench-fortress or semi-open warfare, still, if conditions permit, divisional-artillery-proof buildings should be made for O.Ps. the positions of which should, of course, be very

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carefully concealed by camouflage. Underground shelters should be made for the crews of O.Ps. also of machine gun batteries, and for battalion and brigade Headquarters, if existing (above ground) buildings and cellars, etc., can not be found. If conditions still permit, then make underground shelters for garrisons of strong points also.

In the execution of the work, as in every class of work where only a few men can be employed in any one place, and the rate of progress is slow, two days shifts should be put on, or three shifts of eight hours each, *i.e.*, continuous work all round the clock, in under-ground work or wherever artificial lighting can be arranged for. It is better to have only one-half or one-third the number of jobs in hand simultaneously, and to work two or three shifts; the golden rule being to get something useable finished and wiped off the slate quickly. After a little practice dug-out work can be done by unskilled labour such as Chinese.

Geological conditions and subsoil water should be studied and trial borings always made before starting work on any dug-out.

(To be followed by "Notes on Trench War" by Major H. A. S. Pressey, M.C., R.E.).

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PROPORTIONING CONCRETE.

By MAJOR A. ff. GARRETT, R.E.

IN the *R.E. Journal* of November, 1918, page 202, is a transcript of a paper on the above subject by H. C. Johnson and W. Kingston with an editorial note by the Editor of "Concrete." The authors have evidently exercised great care over their tests and experiments, but the results appear to be inconclusive, and the conclusions they arrive at differ in some respects from those of the editorial note. Now I think that most of the anomalous results and discrepancies in these experiments (and also in many others) will be cleared up, if the general laws of proportioning of concrete are considered *ab initio*. The fundamental laws for proportioning to secure the maximum strength are as follows :—

1. The strength of concrete varies, within limits, with the percentage of cement.

2. If the percentage of cement is constant, then the strongest concrete will be that in which conjointly—

(*a*). The ratio of the total surface areas of all the particles of the aggregate and sand to the finished volume of the concrete is a minimum.

(*b*). There are no voids.

3. The quantity of water for maximum strength must be the minimum required to secure thorough hydration of the cement combined with proper mixing and working of the concrete.

4. The aggregate and sand must be clean, and the crushing strength of the aggregate must be at least equal to the required strength of the finished concrete.

It is believed that the above four laws, and the consequences to be deduced therefrom, cover all the various theories which have been put forward from time to time by various writers and experimenters. They will be almost self-evident if we consider what a concrete mixture essentially consists of. It is composed of an active cementing material in a fine state of division, mixed with a quantity of inert material, consisting of pieces of stone and particles of sand of all sizes and shapes from say three inches downwards.

Now the only way in which the cement can weld the whole together is by forming a thin film over the surfaces of the aggregate, and it is at once obvious that the more cement there is, the thicker and

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stronger this cementing film will be, and on the other hand, if the quantity of cement is limited, then the smaller the total of the surfaces to be cemented, the stronger will be the concrete. It is perhaps unnecessary to labour the point, but it is so fundamental that a further illustration may be given. Suppose the aggregate to consist of one inch cubes. For one cubic foot of cement we would require 1,728 such cubes, and the total area of the surfaces to be cemented together would be $1,728 \times 6 = 10,368$ square inches, as each cube has six faces each of which has to be cemented.

Now suppose we had to deal with 2-inch cubes. To make one cubic foot we should require 216 2-inch cubes, and the surface to be cemented would be only $216 \times 24 = 5,184$ square inches, or half the area in the case of the one inch cubes. In other words we should only require half the quantity of cement for an equally strong concrete. Of course, the aggregate does not consist of cubes, but of particles of every conceivable shape, but the same principle applies and is expressed in law 2 (*a*) above. But in addition to the sums of the surface areas being kept to a minimum, there must be no voids, and this introduces many complications. Starting with say two inch broken stone, we require a quantity of say one inch stone to fill the interstices between the two inch, a further quantity of half inch to fill the interstices between the one inch, and so on until we finally arrive at the finely ground cement, filling the interstices between the grains of the finest sand which is used. But as fine particles have a larger surface area compared with their volume than larger particles, the principle to be observed is not to use more fine sand than is absolutely necessary to fill the voids. The above considerations explain at once —

(*a*). Why too much fine sand always weakens mortar or concrete.
(*b*). Why a concrete of large aggregate is stronger than a concrete compound of smaller aggregate.
(*c*). Why the densest concrete is always the strongest concrete.

It will also be seen that accurate proportioning is of great importance.

As regards quantity of water, any excess of water beyond that required for hydration and working the concrete is objectionable because—

(i.) Water occupies volume, and if in excess must therefore decrease the density of the concrete.
(ii.) The object being to form a paste of cement and water, and to coat every particle of the aggregate and sand with this paste, it follows that any excess of water will dilute the paste and make it thin and weak, and the excess will rise to the surface of the concrete and drain away, carrying the cement particles with it.

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Examined in the light of the above considerations, the result of the experiments of Messrs. Johnson and Kingston are easily explained. It will be noticed that their "corrected concrete" shows a marked improvement in every case where the original mixture contained *fine* sand. In the three cases in which the corrected concrete shows a decrease in strength the original mixture was made with coarse sand, and the decrease must be explained by the fact that the method of proportioning used is not sound. This is evident when we notice that in every case where there was a decrease the density of corrected concrete is less than that of the standard 1:2:4 mixture. While the method of proportioning proposed aims at obtaining the densest concrete, the table of results clearly shows that this desirable result was not always obtained, and the whole process strikes one as too rough and ready. When any considerable amount of concrete work has to be carried out, we require much more careful proportioning than can be carried out by adding sand, etc., until a "workable" concrete is obtained.

Opinions are bound to differ greatly as to the exact point at which a concrete becomes workable, and the best and strongest concrete will only be obtained by such methods by a lucky fluke, though doubtless considerable improvement may be effected over a simple 1:2:4 specification.

The most practical method of securing a really satisfactory mixture is probably that described by Taylor and Thompson in their book "Concrete, plain and reinforced," a book which should be studied by every engineer who has a large amount of cement concrete work to carry out.

Mr. William B. Fuller carried out a very large number of tests with various materials in order to determine the maximum density curve, and he gives formulæ whereby this may be determined for crushed stone and sand, for gravel and sand, for crushed stone and screenings, and for various sizes of aggregate. The maximum density curve is plotted on a diagram in which the abscissæ represent the diameters of the meshes of sieves used for the granulometric analysis of the aggregate, and the ordinates the percentages by weight which pass through these sieves. It only takes a few minutes to make a granulometric analysis of any sand or aggregate, and the necessary sieves of varying numbers of meshes to the inch can be extemporized very cheaply. Having got granulometric analysis of the various sands, gravels, crushed stone, etc., which may be available, the problem is to combine them in such proportions as to ensure the resulting mixture approaching as nearly as possible to the maximum density curve. The best practical method of doing this is described in Taylor and Thompson's book Appendix I., and though it at first sight appears to be somewhat difficult and complicated, this method after a very little experience will be found

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eminently practical, and it deserves to be much more widely known and recognized than it at present appears to be. Experiments made at Karachi by the writer and Major Harston in 1917 showed that a combination of 1 cement, 1½ sand, 1½ river gravel, 3 hill gravel, (a 1:6 concrete), gave a curve almost identical with the maximum density curve, and gave a crushing strength on 3-in. cubes after 28 days of nearly 2,400 lbs. per sq. inch, as against 1,900 lbs. with the old 1:2:4 mixture previously employed, which contained an excess of fine particles. The granulometric analysis of the two mixtures were :—

OLD 1:2:4 MIXTURE.

Percentage by weight passing sieves of meshes.

·75 inch	100
·50 ,,	94
·20 ,,	73
·13 ,,	54
·10 ,,	49
·07 ,,	41
·04 ,,	30

CORRECTED MIXTURE.

Percentage by weight passing sieves of meshes.

·75 inch	100
·50 ,,	79
·20 ,,	45
·13 ,,	39
·10 ,,	36
·07 ,,	33
·04 ,,	25

As regards quantity of water, experiments at Karachi made by crushing 3-in. cubes after one week gave the following average results—

Percentage water by volume.	Crushing strength lbs. per sq. inch.
5 per cent.	700
7½ ,,	1,200
10 ,,	1,320
12½ ,,	1,390
15 ,,	1,170
17½ ,,	830
20 ,,	470

The maximum strength is therefore obtained with about 12% of water by volume of the total volume of dry aggregate. This agrees very closely with Taylor and Thompson's results of maximum strength with 7½% water by weight, which with an aggregate weighing 105 lbs. per cubic ft. would correspond to 12·7% by volume. This

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is about 75 gallons of water per hundred cubic feet of dry mixture. In reinforced work, however, it is often necessary to use more water to get the concrete to flow freely round the steel.

I would suggest that any further experiments should be carried out on the basis of Mr. Fuller's maximum density curves, in order to avoid needless exploration of ground already covered, and consequent waste of effort. While Mr. Fuller's curves may not, and probably do not, give absolutely the strongest concrete for all classes of material, they certainly do form a scientific basis to start from, and will be found to give results vastly superior to any haphazard or rule of thumb method. It may be confidently predicted that if Messrs. Johnson and Kingston will proportion their concrete according to Mr. Fuller's curves, they will obtain even better results than with their "corrected" mixtures.

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CONCRETE FLOORING TILES.

By LIEUT.-COLONEL ARTHUR A. CROOKSHANK, R.E., and LIEUT. N. JOHNSTON, R.E.

TOWARDS the end of the Summer of 1917, the Concrete age began to take the place of the Timber age, owing to the fact that timber, and especially sawn timber, was getting scarce. With the approach of winter it became necessary to devise some means of providing hard floors for horse standings, stables, cart and horse water points, etc., *i.e.*, for places which had managed to struggle through the summer without hard floors by having their sites frequently changed: and which would normally have been provided in winter with floors made of rough logs, forest planks or bricks (the latter were also beginning to peter out). Cement was fairly plentiful, sand was obtainable locally and ballast procurable in limited quantities: it was consequently decided to try concrete flooring slabs or tiles, laid dry so as to make a portable floor, which could be taken up, carried away and used again, if necessary.

The design of the tiles was based on the following conditions:—

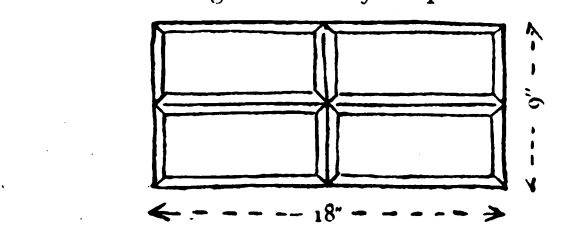
(1). The tile to be handle-able by one man, if possible, and, at any rate, by not more than two.

(2). To be strong enough to stand a load, when in floor (with nothing serious in the way of foundation under it) of horses "crowded at a check."

(3). To be suitable for wet swabbing over, *i.e.*, to drain off easily.

(4). To have a hard iron-shoe-proof surface, but yet to be not too smooth or skiddery a flooring.

After various trials the design eventually adopted was as in Sketch.



Longit. Section.

Cross Section of chamfering of tile or of beading in mould.

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Reinforcement, in the shape of wire netting, expanded metal or heavy plain wire was not added, as the tiles were only to stand the live load of horses and men, and not the strain of a bursting shell.

The longside of the tile was laid at right angles to the horse (in a standing), so that the bevelled pattern not only saved the edges from being chipped in handling and in transit, but provided, with the short cutting across the middle, continuous channels over the floor for surface liquids to run down, and for swabbing, the tiles being laid with broken joints.

The two cuttings, short and long, with the bevelled edges, broke up the large smooth surface of the tile and prevented the horses from slipping up and skidding on the floors when the tiles were new: the largest slippery space measuring 8 in. $\times 3\frac{1}{2}$ in.

The top, or face of the tile should be given a hard and smooth surface, in imitation of the glazed flooring tiles of peace time practice, otherwise those animals which will not stand still in the stable, and which frequently stamp their feet, will very soon break up the surface by hammering, especially as, on Service, the tiles often have to be laid "hot," so to speak: one cannot wait for them to set properly (a process which takes a considerable time in a climate like the autumn in Flanders). They are snapped up by excited and impatient crowds waiting outside the factory for their daily ration, not handled too gently, and then put into floor, wet or green, for heavy draught Clydesdales to immediately fall upon and paw.

The hard surface was obtained by making the top quarter inch of the tile (or the bottom quarter inch in the mould, *i.e.*, the depth of the "pattern," of neat cement.

The next problem to be decided upon was the prescription or recipe for the concrete. In concrete work of any kind it is a great mistake to blindly follow the empirical formulæ given in Engineering Text-books, such as 4 : 2 : 1 or 8 : 4 : 1. The correct proportions vary directly with the nature of each of the ingredients available or procurable, and can, therefore, only be determined by experiment with the materials to be actually used on the work.

What one wants, and what one is driving at in concrete, is a substance of which any one part will not fail much easier than the others, under the loads for which it is designed. The interstices between the stones require to be filled with an equally hard substance, and each stone should also have a thin covering or wrap of the substance all round it, *i.e.*, each plum should be bedded in the matrix and not in direct contact with its neighbour. Concrete wants to be designed, also, according to the work it is going to do: a concrete designed for the floor of an ablution room to carry infantry crowded at a check, should not be used in an engine room floor, where heavy machinery will be mounted on it, or in

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a high wall carrying a heavy roof. For the light weight floor, a soft ballast like broken brick or sand-stone might do.

A case has occurred in which an officer designed a concrete for the floors of open or roofless stables, in which the aggregate consisted of small lumps of soft chalk. Unfortunately, he did not stop at the design: he went further, and covered a considerable tract of country with these standings.

It may be taken for granted that this so-called "concrete" was more useful to the horses for tooth-powder in dry weather, or as a soft bedding in wet weather (being not roofed over), than as a hard floor to stamp about on.

In designing concrete the first thing to do is to obtain the correct proportion between the ballast and the mortar (or aggregate and matrix). This varies greatly, according to the nature of the ballast; for instance, with lime-stone broken to a 3-in. ring, over 50 per cent. of the volume would be voids; but if the stone varies in size, from say 2 in down to $\frac{1}{4}$ in., the voids are less than 30 per cent.: $2\frac{1}{2}$-in. ring gravel, free of sand, has 34 per cent. voids.

On Field Service, one usually has little or no choice of materials. You consequently take the ballast as you find it, or as it is given you, fill a bucket or oil tin with it, then pour in water till the ballast is awash, measuring the water as it goes in. This gives you the amount of voids: add, say, 20 per cent. more, to separate the stones from each other and to avoid having them touching: this gives you the proportion of ballast to mortar. In first-class work the excess should be 40 per cent. over the volume of the voids, instead of 20 per cent.

We now want to know the recipe for the mortar: this must be determined by trial and error experiments. Again Text-book formulæ cannot be used, because cement on Field Service is often not up to sample. Allowance must be made for war profiteering, also for deterioration due to the cement not being properly stored and cared for. Sand on Field Service is frequently of poor quality, a case of "Hobson's choice." Here the same principle applies, as in the case of the ballast and mortar: each grain of sand must be completely surrounded by cement. As in the case of the aggregate, if the sand is graded, *i.e.*, sands of different sized grains are blended together, a great saving in cement will result. For instance, by using ballast consisting of stones of various sizes, the voids in the stones can be reduced to 35 per cent., and by using sand of different sized grains, the voids in the sand can be reduced to 33 per cent., *i.e.*, by having a range of size in both your stones and your sand, a poor and cheap concrete, consisting of ballast : sand : cement :: 8 : 3 : 1 parts, will be just efficient as a rich and costly concrete in which the proportions are—ballast : sand : cement :: 4 : 2 : 1, and in which the ballast and sand grains are not "Graded" and the voids consequently amount to 50 per cent.; although the

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poor concrete uses only half as much cement as the rich, *i.e.*, the rich and expensive concrete uses twice as much cement as the other, and is no better for it.

As regards sand, angular grains give the greatest tensile strength, and round grains the greatest compression strength.

Take the sand and cement as found: mix it in several different proportions, make up a briquette from each mixture, and choose the one which sets best and which gives the biggest breaking loads.

The designs for both tile and concrete having been got out, the next thing to do is to get your concrete tile factory started and to organise for works efficiency, eliminate all wastage in materials, wastage in labour, get each man employed at the kind of work for which he is best suited by nature and by training, and then see that he does no useless movements or actions, *i.e.*, no work which could be done by a cheaper and lower class of labour, *i.e.*, eliminate all wastage of his energy and get the best value out of him.

A factory, on a very small scale, was sited near a stream, as the ballast or aggregate had to be washed, and started under the charge of Lieut. N. Johnston, of an Army Troops Co., R.E., in June, 1917. This small factory is not to be compared with big factories employing a large number of hands, and using narrow gauge railways and concrete mixing machinery capable of turning out 80 yards of mixture per one shift day, and other gadgets or elaborate labour-saving machines.

The following results were obtained by Lieut. Johnston:—

Concrete.—The best aggregate was that obtained by passing through $\frac{3}{4}$ in. sq. mesh sieve; it was gravel which had to be well washed; it contained all sizes, from $\frac{3}{4}$ in. downwards, and a good deal of sharp, coarse sand, *i.e.*, it had a good range in sizes, and was well graded.

When sand was not procurable, the concrete was made of gravel : cement :: 4 : 1. A mixture at 5 : 1 was tried, and found unsatisfactory.

When sand was available, the best mixture was found to be gravel : sand : cement :: $3\frac{1}{2}$: 1 : 1.

A mixture of sand : cement :: 4 : 1 (*i.e.*, no gravel) was found to be unsatisfactory, probably owing to the sand being all of very small grains of about the same size. A sand with large, medium and small grains, would probably give good results.

Moulds.—A stretcher pattern mould, carried by two men and holding four tiles lying flat, *i.e.*, the tiles were cast horizontally, was found to be the best under the following conditions:—When

(1). Blocks are not larger than 18 in. × 9 in. × $2\frac{1}{2}$ in.
(2). A large mixing and moulding shed is not available.
(3). A Tip-truck railway system is not available for pouring concrete into moulds.

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The above type of mould is economical in floor space (for stacking) and easy for man-handling, and has also other advantages explained later on.

In a factory on a larger scale using concrete mixing machinery, a narrow gauge railway system with Tip-trucks, big buildings, and a great amount of labour, moulds in which the tiles are cast vertically on edge (like a shelf of books) between sheet iron partitions, enable the moulds to be filled up quicker than with the horizontal mould, but they require much greater floor space, a longer time for the concrete to set (having only one edge exposed to weather, instead of the whole flat surface, and the mould made of iron instead of wood) it is impossible to have a hard face of neat cement, a good pattern in it, or to turn out a neat and clean edged tile, and the "strata," or planes of settlement in the concrete, run the wrong way.

Method of manufacture, and sizes of gangs :—

(1). Cleaning Gravel.—Two men.
(2). Mixing Gravel by hand.—Five men.
(3). Cleaning Moulds.—Six men.
(4). Oiling Moulds (with Linseed Oil).—Two men.
(5). Filling Moulds.—Two men with a mate (who shovels the concrete out of buckets into the moulds) can turn out 50 to 60 tiles an hour.
(6). Removing and Stacking Moulds, also Stacking Tiles.—Four men.

The tiles are left 48 hours in the moulds under cover before being stacked out in the open.

The above gangs, amounting to 22 men, can turn out, at a push, 500 to 700 tiles a day.

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MEMOIR.

BRIG.-GENERAL HUBERT JOHN FOSTER.

COLONEL (T/BRIG.-GENERAL) H. J. FOSTER, R.E., retired, who died on the 21st March last, at Cooma, New South Wales, was the youngest and oldest surviving son of the late John N. Foster of Sandy Place, Beds.

After receiving a classical education at Harrow, where he won the gold medal for mathematics, he passed into the Royal Military Academy, Woolwich, being the first Harrow boy to pass direct from Harrow. He passed first into the Royal Engineers, receiving the Sword of Honour, and the Pollock Gold Medal. After the usual training at the School of Military Engineering he was posted to the 31st Company, R.E., which was sent to Cyprus on occupation of that island by a force under Lord Wolsely, 1878. Later he joined the Telegraph Troops at Aldershot, going with it on active service to Egypt in 1882. He was present at the engagement of Kassassin, the battle of Tel-el-Kebir, and occupation at Cairo. He was next posted to the 1st Company, R.E., at Gibraltar.

Sitting for the Staff College Examination in 1883 he passed first of the R.E. candidates. After a course of two years he received Staff College Certificate, passing with honours in French and Mathematics, and in extra languages—Italian, Russian, and Modern Greek.

After leaving the Staff College he was on secret service reconnaissance duty in Greece for the Foreign Office and Admiralty in connection with the Naval Blockade which averted the Turco-Greece war, 1886, and received thanks of Admiralty for this work.

He served a term as Brigade Major, R.E. Irish Command, Dublin, and was then transferred to the Intelligence Department, War Office. doing duty with the section dealing with the British Empire, where he acquired a good knowledge of the Dominions and Colonies. This duty included correction of Colonial Defence schemes and collaboration with the Secretary of the Colonial Defence Committee, Colonel Sir George Clarke, R.E. (now Lord Sydenham), and with Admiral Sir Cyprian Bridge, Director of Naval Intelligence. It also entailed consultation with the Foreign Office and the Colonial Office, and the drafting of papers on Imperial Defence and Strategy for the War Office, the Colonial Defence Committee, and occasionally for the Prime Minister of the day.

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After five years at the Intelligence Department, he was sent on a special confidential mission to Canada in 1895 and to the United States in 1897.

Subsequently appointed Staff Officer of Engineers in the Scottish Command, and he was offered command of the Telegraph Company but preferred duty with the government of Canada, as Quarter-Master General, and later acted for a year as Chief of Staff to General Hatton, G.O.C., Canada. This work took him all over Canada, and he acquired knowledge of the country and its military forces, so that the Cabinet asked him to become Commandant of the Canadian Military College, Kingston. He, however, accepted the War Office offer of Colonel of a division of the Intelligence Department—which appointment however fell through owing to the South African war necessitating economy.

He was appointed Military Attaché to the Embassy at Washington. During three years in this position he made a thorough study of the U.S. and the Army Headquarters. He travelled continually over the country, some 10,000 miles yearly, visiting the various military posts and the coast defences, arsenals, etc., and attending all manœuvres. He formed excellent relations with the senior officers of the army and gained a thorough knowledge of the United States and its army.

He was Military Attaché in Mexico to H.M. Legation travelling in the country and, writing for the War Office, a book on the army and military situation of Mexico.

On return to London he was again posted to the Intelligence Department. While there he wrote a book on the strategic aspect of the Canadian Frontier.

In 1906, he accepted the appointment of Director of Military Science at the University of Sydney, with position of General Staff Officer, British Army During his nine years tenure of that position he lectured continuously on Imperial Defences, Military History, Strategy, and Tactics, and held annually several Staff Courses in the field for senior officers, which were attended by some hundreds of senior officers, including nearly all those who have commanded divisions in this war:—Sir W. Bridges, Sir H. Chauval, Major-Generals McCay-Holmes, Monash, Hobbs, many Brigadier-Generals and Commanding Officers. During this period he wrote the following books in connection with his work:—*Defence of the Empire, A Tactical Exercise, Organisation: On How Armies are Formed for War, Staff Work, War and the Empire.*

He also wrote constantly for the press, and gave lectures to the public on military matters, especially on the war in 1914/15. In December, 1915, he accepted temporary service in the Department of Defence, acting Chief of the General Staff, Dept. of Defence.

Brigadier-General Foster travelled extensively. He knew every

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country in Europe, except Serbia, and knew Western Europe well. Having served in Gibraltar, Egypt, and Cyprus, he studied the Mediterranean from Spain to Constantinople and Morocco, Algiers, Tunis, Syria, and Greece. All his service he made a study of the geography, history, languages, peoples and politics of most European countries. During eleven years of his service, he went all over the American Continent from Cuba and Mexico to Alaska, and knew Canada and the United States well.

He had twelve years residence and travel in Australia and visited New Zealand, India, Ceylon, China, and Japan. He had some personal knowledge of the whole British Empire and long made a serious study of its geography, history, external politics, and especially of its defence. He made many journeys to South Asia, India, Malaya, Siam, Java, and other of the Dutch Islands, French Indo-China, the Phillipines, New Guinea, thus greatly extended his knowledge of the countries adjoining Australia.

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TRANSCRIPT.

FIELD MARSHAL SIR DOUGLAS HAIG ON THE "FEATURES OF THE WAR."

From the Fourth Supplement to *The London Gazette* of Tuesday, 8th April, 1919.

[WE are departing in this instance from our usual practice of publishing Extracts from Dispatches only in the *Supplement to R.E. Journal* and reproduce below Part II. of Sir Douglas Haig's final dispatch, since it furnishes a general review of the whole war.—EDITOR, *R.E. Journal.*]

o o o o o

(10) In this, my final Dispatch, I think it desirable to comment briefly upon certain general features which concern the whole series of operations carried out under my command. I am urged thereto by the conviction that neither the course of the war itself nor the military lessons to be drawn therefrom can properly be comprehended, unless the long succession of battles commenced on the Somme in 1916 and ended in November of last year on the Sambre are viewed as forming part of one great and continuous engagement.

To direct attention to any single phase of that stupendous and incessant struggle and seek in it the explanation of our success, to the exclusion or neglect of other phases possibly less striking in their immediate or obvious consequences is, in my opinion, to risk the formation of unsound doctrines regarding the character and requirements of modern war.

If the operations of the past 4½ years are regarded as a single continuous campaign, there can be recognized in them the same general features and the same necessary stages which between forces of approximately equal strength have marked all the conclusive battles of history. There is in the first instance the preliminary stage of the campaign in which the opposing forces seek to deploy and manœuvre for position, endeavouring while doing so to gain some early advantage which might be pushed home to quick decision. This phase came to an end in the present war with the creation of continuous trench lines from the Swiss frontier to the sea.

Battle having been joined, there follows the period of real struggle in which the main forces of the two belligerent Armies are pitted against each other in close and costly combat. Each commander seeks to wear down the power of resistance of his opponent and to pin him to his position, while preserving or accumulating in his own hands a powerful reserve force with which he can manœuvre, and when signs of the enemy becoming morally and physically weakened are observed, deliver the decisive attack. The greatest possible pressure against the enemy's whole front must be maintained, especially when the crisis of the battle approaches. Then every man, horse, and gun is required to co-operate, so as to complete the enemy's overthrow and exploit success.

In the stage of the wearing out struggle losses will necessarily be

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heavy on both sides, for in it the price of victory is paid. If the opposing forces are approximately equal in numbers, in courage, in moral and in equipment, there is no way of avoiding payment of the price or of eliminating this phase of the struggle.

In former battles this stage of the conflict has rarely lasted more than a few days, and has often been completed in a few hours. When Armies of millions are engaged, with the resources of great Empires behind them, it will inevitably be long. It will include violent crises of fighting which, when viewed separately and apart from the general perspective, will appear individually as great indecisive battles. To this stage belong the great engagements of 1916 and 1917 which wore down the strength of the German Armies.

Finally, whether from the superior fighting ability and leadership of one of the belligerents, as the result of greater resources or tenacity, or by reason of higher moral, or from a combination of all these causes, the time will come when the other side will begin to weaken and the climax of the battle is reached. Then the commander of the weaker side must choose whether he will break off the engagement, if he can, while there is yet time, or stake on a supreme effort what reserves remain to him. The launching and destruction of Napoleon's last reserves at Waterloo was a matter of minutes. In this World War the great sortie of the beleaguered German Armies, commenced on the 21st March, 1918, lasted for four months, yet it represents a corresponding stage in a single colossal battle.

The breaking down of such a supreme effort will be the signal for the commander of the successful side to develop his greatest strength and seek to turn to immediate account the loss in material and moral which their failure must inevitably produce among his opponent's troops. In a battle joined and decided in the course of a few days or hours, there is no risk that the lay observer will seek to distinguish the culminating operations by which victory is seized and exploited from the preceding stages by which it has been made possible and determined. If the whole operations of the present war are regarded in correct perspective the victories of the summer and autumn of 1918 will be seen to be as directly dependent upon the two years of stubborn fighting that preceded them.

(11) If the causes which determined the length of the recent contest are examined in the light of the accepted principles of war, it will be seen that the duration of the struggle was governed by and bore a direct relation to certain definite factors which are enumerated below.

In the first place, we were unprepared for war, or at any rate for a war of such magnitude. We were deficient in both trained men and military material, and, what was more important, had no machinery ready by which either men or material could be produced in anything approaching the requisite quantities. The consequences were two-fold. Firstly, the necessary machinery had to be improvised hurriedly, and improvisation is never economical and seldom satisfactory. In this case the high-water mark of our fighting strength in infantry was only reached after $2\frac{1}{2}$ years of conflict, by which time heavy casualties had already been incurred. In consequence, the full man power of the Empire was never developed in the field at any period of the war.

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As regards material, it was not until midsummer, 1916, that the artillery situation became even approximately adequate to the conduct of major operations. Throughout the Somme battle the expenditure of artillery ammunition had to be watched with the greatest care. During the battles of 1917 ammunition was plentiful, but the gun situation was a source of constant anxiety. Only in 1918 was it possible to conduct artillery operations independently of any limiting consideration other than that of transport.

The second consequence of our unpreparedness was that our Armies were unable to intervene, either at the outset of the war or until nearly two years had elapsed, in sufficient strength adequately to assist our Allies. The enemy was able to gain a notable initial advantage by establishing himself in Belgium and northern France, and throughout the early stages of the war was free to concentrate an undue proportion of his effectives against France and Russia. The excessive burden thrown upon the gallant Army of France during this period caused them losses, the effect of which has been felt all through the war and directly influenced its length. Just as at no time were we as an Empire able to put our own full strength into the field, so at no time were the Allies as a whole able completely to develop and obtain the full effect from their greatly superior man power. What might have been the effect of British intervention on a larger scale in the earlier stages of the war is shown by what was actually achieved by our original Expeditionary Force.

It is interesting to note that in previous campaigns the side which has been fully prepared for war has almost invariably gained a rapid and complete success over its less well prepared opponent. In 1866 and 1870, Austria, and then France, were overwhelmed at the outset by means of superior preparation. The initial advantages derived therefrom were followed up by such vigorous and ruthless action, regardless of loss, that there was no time to recover from the first stunning blows. The German plan of campaign in the present war was undoubtedly based on similar principles. The margin by which the German onrush in 1914 was stemmed was so narrow and the subsequent struggle so severe that the word "miraculous" is hardly too strong a term to describe the recovery and ultimate victory of the Allies.

A further cause adversely influencing the duration of the war on the Western front during its later stages, and one following indirectly from that just stated, was the situation in other theatres. The military strength of Russia broke down in 1917 at a critical period, when, had she been able to carry out her military engagements, the war might have been shortened by a year. At a later date, the military situation in Italy in the autumn of 1917 necessitated the transfer of five British divisions from France to Italy, at a time when their presence in France might have had far-reaching effects.

Thirdly, the Allies were handicapped in their task and the war thereby lengthened by the inherent difficulties always associated with the combined action of Armies of separate nationalities, differing in speech and temperament, and, not least important, in military organization, equipment, and supply.

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Finally, as indicated in the opening paragraph of this part of my Dispatch, the huge numbers of men engaged on either side, whereby a continuous battle front was rapidly established from Switzerland to the sea, outflanking was made impossible and manœuvre very difficult, necessitated the delivery of frontal attacks. This factor, combined with the strength of the defensive under modern conditions, rendered a protracted wearing out battle unavoidable before the enemy's power of resistance could be overcome. So long as the opposing forces are at the outset approximately equal in numbers and moral, and there are no flanks to turn, a long struggle for supremacy is inevitable.

(12) Obviously, the greater the length of a war the higher is likely to be the number of casualties incurred in it on either side. The same causes, therefore, which served to protract the recent struggle are largely responsible for the extent of our casualties. There can be no question that to our general unpreparedness must be attributed the loss of many thousands of brave men whose sacrifice we deeply deplore, while we regard their splendid gallantry and self-devotion with unstinted admiration and gratitude.

Given, however, the military situation existing in August, 1914, our total losses in the war have been no larger than were to be expected. Neither do they compare unfavourably with those of any other of the belligerent nations, so far as figures are available, from which comparison can be made. The total British casualties in all theatres of war, killed, wounded, missing, and prisoners, including native troops, are approximately three millions (3,076,388). Of this total some two and a half millions (2,568,834) were incurred on the Western front. The total French losses, killed, missing, and prisoners, but exclusive of wounded, have been given officially as approximately 1,831,000. If an estimate for wounded is added, the total can scarcely be less than 4,800,000, and of this total it is fair to assume that over four millions were incurred on the Western front. The published figures for Italy, killed and wounded only, exclusive of prisoners, amount to 1,400,000, of which practically the whole were incurred in the Western theatre of war.

Figures have also been published for Germany and Austria. The total German casualties, killed, wounded, missing, and prisoners, are given at approximately six and a half millions (6,485,000) of which the vastly greater proportion must have been incurred on the Western front, where the bulk of the German forces were concentrated and the hardest fighting took place. In view of the fact, however, that the number of German prisoners is definitely known to be considerably understated, these figures must be accepted with reserve. The losses of Austria-Hungary in killed, missing, and prisoners are given as approximately two and three-quarter millions (2,772,000). An estimate of wounded would give a total of over four and a half millions.

The extent of our casualties, like the duration of the war, was dependent on certain definite factors which can be stated shortly.

In the first place, the military situation compelled us, particularly during the first portion of the war to make great efforts before we had developed our full strength in the field or properly equipped and trained our Armies. These efforts were wasteful of men, but in the circumstances

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they could not be avoided. The only alternative was to do nothing and see our French Allies overwhelmed by the enemy's superior numbers.

During the second half of the war, and that part embracing the critical and costly period of the wearing out battle, the losses previously suffered by our Allies laid upon the British Armies in France an increasing share in the burden of attack. From the opening of the Somme Battle in 1916 to the termination of hostilities the British Armies were subjected to a strain of the utmost severity which never ceased, and consequently had little or no opportunity for the rest and training they so greatly needed.

In addition to these particular considerations, certain general factors peculiar to modern war made for the inflation of losses. The great strength of modern field defences and the power and precision of modern weapons, the multiplication of machine guns, trench mortars, and artillery of all natures, the employment of gas, and the rapid development of the aeroplane as a formidable agent of destruction against both men and material, all combined to increase the price to be paid for victory.

If only for these reasons, no comparisons can usefully be made between the relative losses incurred in this war and any previous war. There is however, the further consideration that the issues involved in this stupendous struggle were far greater than those concerned in any other war in recent history. Our existence as an Empire and civilization itself, as it is understood by the free Western nations, were at stake. Men fought as they have never fought before in masses.

Despite our own particular handicaps and the foregoing general considerations, it is satisfactory to note that, as the result of the courage and determination of our troops, and the high level of leadership generally maintained, our losses even in attack over the whole period of the battle compare favourably with those inflicted on our opponents. The approximate total of our battle casualties in all arms, and including Overseas troops, from the commencement of the Somme Battle in 1916 to the conclusion of the Armistice is 2,140,000. The calculation of German losses is obviously a matter of great difficulty. It is estimated, however, that the number of casualties inflicted on the enemy by British troops during the above period exceeds two and a half millions. It is of interest, moreover, in the light of the paragraph next following, that more than half the total casualties incurred by us in the fighting of 1918 were occasioned during the five months, March-July, when our Armies were on the defensive.

(13) Closely connected with the question of casualties is that of the relative values of attack and defence. It is a view often expressed that the attack is more expensive than defence. This is only a half statement of the truth. Unquestionably, unsuccessful attack is generally more expensive than defence, particularly if the attack is pressed home with courage and resolution. On the other hand, attack so pressed home, if skilfully conducted, is rarely unsuccessful, whereas in its later stages especially, unsuccessful defence is far more costly than attack.

Moreover, the object of all war is victory, and a purely defensive attitude can never bring about a successful decision, either in a battle or in a campaign. The idea that a war can be won by standing on the defensive and waiting for the enemy to attack is a dangerous fallacy,

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which owes its inception to the desire to evade the price of victory. It is an axiom that decisive success in battle can be gained only by a vigorous offensive. The principle here stated has long been recognized as being fundamental and is based on the universal teaching of military history in all ages. The course of the present war has proved it to be correct.

To pass for a moment from the general to the particular, and consider in the light of the present war the facts upon which this axiom is based.

A defensive *rôle* sooner or later brings about a distinct lowering of the moral of the troops, who imagine that the enemy must be the better man, or at least more numerous, better equipped with and better served by artillery or other mechanical aids to victory. Once the mass of the defending infantry become possessed of such ideas, the battle is as good as lost. An Army fighting on enemy soil, especially if its standard of discipline is high, may maintain a successful defence for a protracted period, in the hope that victory may be gained elsewhere or that the enemy may tire or weaken in his resolution and accept a compromise. The resistance of the German armies was undoubtedly prolonged in this fashion, but in the end the persistence of our troops had its natural effect.

Further, a defensive policy involves the loss of the initiative, with all the consequent disadvantages to the defender. The enemy is able to choose at his own convenience the time and place of his attacks. Not being influenced himself by the threat of attack from his opponent, he can afford to take risks, and by greatly weakening his front in some places can concentrate an overwhelming force elsewhere with which to attack. The defender, on the other hand, becomes almost entirely ignorant of the dispositions and plans of his opponent, who is thus in a position to effect a surprise. This was clearly exemplified during the fighting of 1918. As long as the enemy was attacking, he obtained fairly full information regarding our dispositions. Captured documents show that, as soon as he was thrown once more on the defensive and the initiative returned to the Allies, he was kept in comparative ignorance of our plans and dispositions. The consequence was that the Allies were able to effect many surprises, both strategic and tactical.

As a further effect of the loss of the initiative and ignorance of his opponent's intentions, the defender finds it difficult to avoid a certain dispersal of his forces. Though for a variety of reasons, including the fact that we had lately been on the offensive, we were by no means entirely ignorant of the enemy's intentions in the spring of 1918, the unavoidable uncertainty resulting from a temporary loss of the initiative did have the effect of preventing a complete concentration of our reserves behind the point of the enemy's attack.

An additional reason, peculiar to the circumstances of the present war, which in itself compelled me to refuse to adopt a purely defensive attitude so long as any other was open to me, is to be found in the geographical position of our Armies. For reasons stated by me in my Dispatch of the 20th July, 1918, we could not afford to give much ground on any part of our front. The experience of the war has shown that if the defence is to be maintained successfully, even for a limited time, it must be flexible.

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(14) If the views set out by me in the preceding paragraphs are accepted, it will be recognized that the war did not follow any unprecedented course, and that its end was neither sudden nor should it have been unexpected. The rapid collapse of Germany's military powers in the latter half of 1918 was the logical outcome of the fighting of the previous two years. It would not have taken place but for that period of ceaseless attrition which used up the reserves of the German Armies, while the constant and growing pressure of the blockade sapped with more deadly insistence from year to year at the strength and resolution of the German people. It is in the great battles of 1916 and 1917 that we have to seek for the secret of our victory in 1918.

Doubtless, the end might have come sooner had we been able to develop the military resources of our Empire more rapidly and with a higher degree of concentration, or had not the defection of Russia in 1917 given our enemies a new lease of life.

So far as the military situation is concerned, in spite of the great accession of strength which Germany received as the result of the defection of Russia, the battles of 1916 and 1917 had so far weakened her Armies that the effort they made in 1918 was insufficient to secure victory. Moreover, the effect of the battles of 1916 and 1917 was not confined to loss of German man power. The moral effects of those battles were enormous, both in the German Army and in Germany. By their means our soldiers established over the German soldier a moral superiority which they held in an ever-increasing degree until the end of the war, even in the difficult days of March and April, 1918.

(15) From time to time as the war of position dragged on and the enemy's trench systems remained unbroken, while questions of man power and the shortage of shipping became acute, the wisdom or necessity of maintaining any large force of mounted men was freely discussed. In the light of the full experience of the war the decision to preserve the Cavalry Corps has been completely justified. It has been proved that cavalry, whether used for shock effect under suitable conditions or as mobile infantry, have still an indispensable part to play in modern war. Moreover, it cannot safely be assumed that in all future wars the flanks of the opposing forces will rest on neutral States or impassable obstacles. Whenever such a condition does not obtain opportunities for the use of cavalry must arise frequently.

Throughout the great retirement in 1914, our cavalry covered the retirement and protected the flanks of our columns against the onrush of the enemy, and on frequent occasions prevented our infantry from being overrun by the enemy's cavalry. Later in the same year at Ypres, their mobility multiplied their value as a reserve, enabling them rapidly to reinforce threatened portions of our line.

During the critical period of position warfare, when the trial of strength between the opposing forces took place, the absence of room to manœuvre made the importance of cavalry less apparent. Even under such conditions, however, valuable results may be expected from the employment of a strong force of cavalry when, after there has been severe fighting on one or more fronts, a surprise attack is made on another front. Such an occasion arose in the operations before Cambrai at the

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close of 1917, when the cavalry were of the greatest service; while throughout the whole period of trench fighting they constituted an important mobile reserve.

At a later date, when circumstances found us operating once more in comparatively open country, cavalry proved themselves of value in their true *rôle*. During the German offensive in March, 1918, the superior mobility of cavalry fully justified their existence. At the commencement of the battle, cavalry were used under the Fifth Army over wide fronts. So great, indeed, became the need for mounted men that certain units which had but recently been dismounted were hurriedly provided with horses and did splendid service. Frequently, when it was impossible to move forward other troops in time, our mounted troops were able to fill gaps in our line and restore the situation. The absence of hostile cavalry at this period was a marked feature of the battle. Had the German command had at their disposal even two or three well-trained cavalry divisions, a wedge might have been driven between the French and British Armies. Their presence could not have failed to have added greatly to the difficulties of our task.

In the actions already referred to east of Amiens, the cavalry were again able to demonstrate the great advantage which their power of rapid concentration gives them in a surprise attack. Operating in close concert with both armoured cars and infantry, they pushed ahead of the latter and by anticipating the arrival of German reserves assisted materially in our success. In the battle of the 8th October, they were responsible for saving the Cambrai—Le Cateau—St. Quentin Railway from complete destruction. Finally, during the culminating operations of the war when the German Armies were falling back in disorganized masses a new situation arose which demanded the use of mounted troops. Then our cavalry, pressing hard upon the enemy's heels, hastened his retreat and threw him into worse confusion. At such a time the moral effect of cavalry is overwhelming and is in itself a sufficient reason for the retention of that arm.

On the morning of the Armistice, two British Cavalry Divisions were on the march east of the Scheldt, and before the orders to stop reached them they had already gained a line ten miles in front of our infantry outposts. There is no doubt that, had the advance of the cavalry been allowed to continue, the enemy's disorganized retreat would have been turned into a rout.

(16) A remarkable feature of the present war has been the number and variety of mechanical contrivances to which it has given birth or has brought to a higher state of perfection.

Besides the great increase in mobility made possible by the development of motor transport, heavy artillery, trench mortars, machine guns, aeroplanes, tanks, gas, and barbed wire have in their several spheres of action played very prominent parts in operations, and as a whole have given a greater driving power to war. The belligerent possessing a preponderance of such mechanical contrivances has found himself in a very favourable position as compared with his less well provided opponent. The general superiority of the Allies in this direction during the concluding stages of the recent struggle undoubtedly contributed power-

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fully to their success. In this respect the Army owes a great debt to science and to the distinguished scientific men who placed their learning and skill at the disposal of their country.

It should never be forgotten, however, that weapons of this character are incapable of effective independent action. They do not in themselves possess the power to obtain a decision, their real function being to assist the infantry to get to grips with their opponents. To place in them a reliance out of proportion to their real utility, to imagine, for example, that tanks and aeroplanes can take the place of infantry and artillery, would be to do a disservice to those who have the future of these new weapons most at heart by robbing them of the power to use them to their best effect.

Every mechanical device so far produced is dependent for its most effective use upon the closest possible association with other arms, and in particular with infantry and artillery. Aeroplanes must rely upon infantry to prevent the enemy from overrunning their aerodromes, and, despite their increasing range and versatility of action, are clearly incapable in themselves of bringing about a decision. Tanks require the closest artillery support to enable them to reach their objectives without falling victims to the enemy's artillery, and are dependent upon the infantry to hold the position they have won.

As an instance of the interdependence of artillery and tanks, we may take the actions fought east of Amiens on the 8th August, 1918, and following days. A very large number of tanks were employed in these operations, and they carried out their tasks in the most brilliant manner. Yet a scrutiny of the artillery ammunition returns for this period discloses the fact that in no action of similar dimensions had the expenditure of ammunition been so great.

Immense as the influence of mechanical devices may be, they cannot by themselves decide a campaign. Their true *rôle* is that of assisting the infantryman, which they have done in a most admirable manner. They cannot replace him. Only by the rifle and bayonet of the infantryman can the decisive victory be won.

(17) This war has given no new principles; but the different mechanical appliances above mentioned—and in particular the rapid improvement and multiplication of aeroplanes, the use of immense numbers of machine guns and Lewis guns, the employment of vast quantities of barbed wire as effective obstacles, the enormous expansion of artillery, and the provision of great masses of motor transport—have introduced new problems of considerable complexity concerning the effective co-operation of the different arms and services. Much thought has had to be bestowed upon determining how new devices could be combined in the best manner with the machinery already working.

The development of the Air Service is a matter of general knowledge, and figures showing something of the work done by our airmen were included in my last Dispatch. The combining of their operations with those of the other arms, and particularly of the artillery, has been the subject of constant study and experiment, giving results of the very highest value. As regards machine guns, from a proportion of one gun to approximately 500 infantrymen in 1914, our establishment of machine

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guns and Lewis guns had risen at the end of 1918 to one machine gun or Lewis gun to approximately 20 infantrymen. This great expansion was necessarily accompanied by a modification of training and methods both for attack and defence, and resulted ultimately in the establishment of the Machine Gun Corps under an Inspector-General.

During the same period, the growth of our artillery was even more remarkable, its numbers and power increasing out of all proportion to the experience of previous wars. The 486 pieces of light and medium artillery with which we took the field in August, 1914, were represented at the date of the Armistice by 6,437 guns and howitzers of all natures, including pieces of the heaviest calibre.

This vast increase so profoundly influenced the employment of artillery and was accompanied by so intimate an association with other arms and services that it merits special comment.

In the first place, big changes were required in artillery organization, as well as important decisions concerning the proportions in which the different natures of artillery and artillery ammunition should be manufactured. These changes and decisions were made during 1916, and resulted in the existing artillery organization of the British Armies in France.

In order to gain the elasticity essential to the quick concentration of guns at the decisive point, to enable the best use to be made of them and to facilitate ammunition supply and fire control, Artillery Commanders, acting under Army and Corps Commanders, were introduced, and Staffs provided for them. This enabled the large concentrations of guns required for our offensives to be quickly absorbed and efficiently directed. The proportions required of guns to howitzers and of the lighter to the heavier natures were determined by certain factors, namely the problem of siting in the comparatively limited areas available the great numbers of pieces required for an offensive; the "lives" of the different types of guns and howitzers, that is the number of rounds which can be fired from them before they become unserviceable from wear, and questions of relative accuracy and fire effect upon particular kinds of targets.

The results attained by the organization established in 1916 is in itself strong evidence of the soundness of the principles upon which it was based. It made possible a high degree of elasticity, and by the full and successful exploitation of all the means placed at its disposal by science and experience, ensured that the continuous artillery battle which began on the Somme should culminate, as it did, in the defeat of the enemy's guns.

The great development of air photography, sound ranging, flash spotting, air-burst ranging, and aerial observation brought counter-battery work and harassing fire both by day and night to a high state of perfection. Special progress was made in the art of engaging moving targets with fire controlled by observation from aeroplanes and balloons. The work of the Field Survey Sections in the location of hostile battery positions by re-section and the employment of accurate maps was brought into extended use. In combination with the work of the Calibration Sections in the accurate calibration of guns and by careful calculation

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of corrections of range required to compensate for weather conditions it became possible to a large extent to dispense with registration, whereby the chance of effecting surprise was greatly increased. In the operations east of Amiens on the 8th August, 1918, in which over 2,000 guns were employed, practically the whole of the batteries concentrated for the purpose of the attack opened fire for the first time on the actual morning of the assault.

The use of smoke shell for covering the advance of our infantry and masking the enemy's positions was introduced and employed with increasing frequency and effect. New forms of gas shell were made available, and their combination with the infantry attack carefully studied. The invention of a new fuze known as "106," which was first used in the battle of Arras, 1917, enabled wire entanglements to be easily and quickly destroyed, and so modified our methods of attacking organized positions. By bursting the shell the instant it touched the ground and before it had become buried, the destructive effect of the explosion was greatly increased. It became possible to cut wire with a far less expenditure of time and ammunition, and the factor of surprise was given a larger part in operations.

Great attention was paid to the training of *personnel*, and in particular the Chapperton Down Artillery School, Salisbury Plain, was formed for training artillery brigade commanders and battery commanders, while Artillery Schools in France were organized for the training of sulbalterns and non-commissioned officers.

A short examination of our principal attacks will give a good idea of the increasing importance of artillery. On the first day of the Somme Battle of 1916 the number of artillery *personnel* engaged was equal to about half the infantry strength of the attacking divisions. On this one day a total of nearly 13,000 tons of artillery ammunition was fired by us on the Western front. Our attacks at Arras and Messines on the 9th April and 7th June, 1917, saw the total expenditure of artillery ammunition nearly doubled on the first days of those battles, while the proportion of artillery *personnel* to infantry steadily grew.

During the period following the opening of the Somme Battle, the predominance of our artillery over that of the enemy gradually increased, till at the time of the Arras Battle it had reached a maximum. In the course of the summer and autumn of 1917, however, the enemy constantly reinforced his artillery on our front, being enabled to do so owing to the relaxation of pressure elsewhere.

The battle of Ypres in the autumn of 1917 was one of intense struggle for artillery supremacy. By dint of reducing his artillery strength on other parts of the Western front, and by bringing guns from the East, the enemy definitely challenged the predominance of our artillery. In this battle, therefore, the proportion of our artillery to infantry strength was particularly large. In the opening attack on the 31st July our artillery *personnel* amounted to over 80 per cent. of the infantry engaged in the principal attack on our front, and our total expenditure of artillery ammunition on this day exceeded 23,000 tons. During the succeeding weeks the battle of the rival artilleries became ever more violent. On the two days, 20th and 21st September, about 42,000 tons

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of artillery ammunition were expended by us, and in the successful attack of the 4th October, which gave us the main ridge about Broodseinde, our artillery *personnel* amounted to 85 per cent. of the infantry engaged in the assault.

During the winter of 1917–1918 the enemy so greatly added to his artillery strength by batteries brought from the Russian front that in his spring offensive he was able temporarily to effect a definite local artillery superiority. This state of affairs was shortlived. Even before the breakdown of the German offensive, our guns had regained the upper hand. In the battles later in the year the superiority of our batteries once more grew rapidly, until the defeat of the German artillery became an accomplished fact. From the commencement of our offensive in August, 1918, to the conclusion of the Armistice, some 700,000 tons of artillery ammunition were expended by the British Armies on the Western front. For the fortnight from the 21st August–3rd September our average daily expenditure exceeded 11,000 tons, while for the three days of crucial battle on the 27th, 28th, and 29th September nearly 65,000 tons of ammunition were fired by our artillery.

The tremendous growth of our artillery strength above described followed inevitably from the character of the wearing-out battle upon which we were engaged. The restricted opportunities for manœuvre and the necessity for frontal attacks made the employment of great masses of artillery essential.

The massing of guns alone, however, could not have secured success without the closest possible combination between our batteries and the infantry they were called upon to support, as well as with the other arms. The expansion was accompanied, therefore, by a constant endeavour to improve the knowledge of all ranks of both artillery and infantry and the air service concerning the work and possibilities of the other arms.

An intelligent understanding of " the other man's job " is the first essential of successful co-operation. To obtain the best results from the vast and complex machine composing a modern army, deep study of work other than one's own is necessary for all arms. For this study much time is needed, as well as much practical application of the principles evolved, and for reasons already explained, opportunity sufficient for adequate training could not be found. None the less, the best possible use was made of such opportunities as offered, and much was in fact accomplished.

(18) As a natural corollary to the general increase of our Forces, the Signal Service, required alike for the proper co-ordination of supply and for the direction and control of the battle, has grown almost out of recognition. From an original establishment of under 2,400 officers and men, trained and equipped chiefly for mobile warfare, at the end of 1918 the *personnel* of the Signal Service had risen to 42,000, fully equipped with all the latest devices of modern science to act efficiently under all conditions as the nervous system to the whole vast organism of our Army.

The commencement of trench warfare and the greater use of artillery led to a rapid development of the signal system, which as fresh units

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were introduced became more and more elaborate. At the same time, the increase in the power and range of artillery made the maintenance of communications constantly more difficult. Many miles of deep trenches were dug in which cables containing 50 to 100 circuits were buried to gain protection from shell fire. The use of wireless communication gradually became more widely spread and finally constituted part of the Signal establishment of all formations down to divisions. To provide an alternative method of communication with front line troops, in 1915 carrier pigeons were introduced and a special branch of the Signal Service was formed controlling ultimately some 20,000 birds. In 1917 a Messenger Dog Service was started for similar purposes and did good work on a number of occasions.

The expansion of the work of the Signal Service in the more foward areas was accompanied by a similar development on the Lines of Communication, at General Headquarters, Armies, and Corps. Construction and Railway Companies were formed and about 1,500 miles of main telegraph and telephone routes constructed in the Lines of Communication area alone, in addition to many miles in Army areas. Provision had to be made for communicating with London, Paris, and Marseilles, as well as between the different Allied Headquarters. On the advance of our forces to the Rhine telephone communication was established between General Headquarters at Montreuil and Cologne. Signal communication entailing the putting up of many thousands of miles of wire was provided also for the control of railway traffic, while to supplement electric communication generally a Dispatch Rider Letter Service was maintained by motor cyclists.

The amount of Signal Traffic dealt with became very great, and on the Lines of Communication alone more than 23,000 telegrams have been transmitted in twenty-four hours. Similarly, at General Headquarters as many as 9,000 telegrams have been dealt with in twenty-four hours, besides 3,400 letters carried by Dispatch Rider; and Army Headquarters has handled 10,000 telegrams and 5,000 letters in the same space of time, and a Corps 4,500 telegrams and 3,000 letters. In addition to telegrams and letters, there has been at all times a great volume of telephone traffic.

Something of the extent of the constructional work required, in particular to meet the constant changes of the battle line and the movement of Headquarters, can be gathered from the fact that as many as 6,500 miles of field cable have been issued in a single week. The average weekly issue of such cable for the whole of 1918 was approximately 3,300 miles.

(19) The immense expansion of the Army from 6 to over 60 infantry divisions, combined with the constant multiplication of auxiliary arms, called inevitably for a large increase in the size and scope of the services concerned in the supply and maintenance of our fighting forces.

As the Army grew and became more complicated the total feeding strength of our forces in France rose until it approached a total of 2,700,000 men. The vastness of the figures involved in providing for their needs will be realized from the following examples. For the main-

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tenance of a single division for one day, nearly 200 tons dead weight of supplies and stores are needed, representing a shipping tonnage of nearly 450 tons. In an Army of 2,700,000 men, the addition of one ounce to each man's daily rations involves the carrying of an extra 75 tons of goods.

To cope with so great a growth, the number of existing directorates had gradually to be added to or their duties extended, with a corresponding increase in demands for personnel. The supervision of ports was entrusted to the Directorate of Docks, which controlled special companies for the transhipping of stores. By the end of November, 1918, the number of individual landings in France at the various ports managed by us exceeded 10½ million persons. During the 11 months January to November, 1918, the tonnage landed at these ports averaged some 175,000 tons per week.

To the Directorate of Transport, originally concerned with the administration of horse vehicles and pack animals, fell the further duty of exploiting mechanical road traction. Despite the employment of over 46,700 motor vehicles, including over 30,000 lorries, the number of horses and mules rose greatly, reaching a figure exceeding 400,000. The replacement, training and distribution of these animals was the duty of the Directorate of Remounts. The Directorate of Veterinary Services reduced losses and prevented the spread of disease, while the Inspector of Horse Feeding and Economies ensured that the utmost value was obtained from the forage and grain consumed.

To meet the requirements of mechanical and horse traffic, the upkeep or construction of a maximum of some 4,500 miles of roadway was entrusted to the Directorate of Roads. Some idea of the work involved may be obtained from the fact that for ordinary upkeep alone 100 tons of road material are required per fortnight for the maintenance of one mile of road. Under this Directorate were organized a number of Road Construction Companies, together with Quarry Companies to supply the necessary metal. In the month of October, 1918, over 85,000 tons of road material were conveyed weekly by motor transport alone, involving a petrol mileage of over 14,000,000 weekly. The total output of stone from the commencement of 1918 to the date of the Armistice amounted to some 3,500,000 tons.

For the working of the existing railways and for the construction or repair of many miles of track, both normal and narrow gauge, railway troops of every description, Operating Companies, Construction Companies, Survey and Reconnaissance Companies, Engine Crew Companies, Workshop Companies, Wagon Erecting Companies, and Light Railway Forward Companies had to be provided. Under the Directorate of Railway Traffic, the Directorate of Construction, and the Directorate of Light Railways, these and other technical troops during 1918 built or reconstructed 2,340 miles of broad gauge and 1,348 miles of narrow gauge railway. Throughout the whole period of their operation they guaranteed the smooth and efficient working of the railway system. In the six months May to October, 1918, a weekly average of 1,800 trains were run for British Army traffic, carrying a weekly average load of approximately 400,000 tons, while a further 130,000 tons were carried

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weekly by our light railways. The number of locomotives imported to deal with this traffic rose from 62 in 1916 to over 1,200 by the end of 1918, while the number of trucks rose from 3,840 to 52,600.

The Inland Water Transport section were organized under a separate Directorate for the working in France and Flanders of the canal and cross-channel barge traffic. On Inland waterways alone an average of 56,000 tons of material were carried during 1918, the extent of waterways worked by us at the date of the Armistice being some465 miles.

The wonderful development of all methods of transportation had an important influence upon the course of events. No war has been fought with such ample means of quick transportation as were available during the recent struggle. Despite the huge increase in the size of Armies, it was possible to effect great concentrations of troops with a speed which, having regard to the numbers of men and bulk of material moved, has never before been equalled. Strategic and tactical mobility has been the guiding principle of our transportation arrangements; but this was itself at all times vitally affected by questions of supply and by the necessity of providing for the evacuation and replacement on a vast scale of the sick and wounded.

The successful co-ordination and economic use of all the various kinds of transportation requires most systematic management, based on deep thought and previous experience. So great was the work entailed in the handling of the vast quantities of which some few examples are given above, so complex did the machinery of transport become and so important was it that the highest state of efficiency should be maintained, that in the autumn of 1916 I was forced to adopt an entirely new system for running our Lines of Communication. The appointment of Inspector-General of Communications was abolished, and the services previously directed by that Officer were brought under the immediate control of the Adjutant-General, the Quartermaster-General, and the Director-General of Transportation. The last mentioned was a new office created with a separate Staff composed for the greater part of civilian experts to deal specifically with transportation questions. At the same time, the command and administration of the troops on the Lines of Communication were vested in a "General Officer Commanding the Lines of Communication Area."

The huge bulk of the supplies to be handled was due not merely to the size of our Army. It arose also from the introduction of new weapons and methods of war, and from the establishment of a higher standard of comfort for the troops. The incessant demands of the fighting forces for munitions were supplied by the Directorate of Ordnance Services, combined with a great expansion of Ordnance Workshops; while the Directorate of Engineering Stores provided on a vast scale the materials required for the construction of trench defences and kindred purposes. For the comfort and well-being of the troops, the Directorate of Supplies stored and distributed in sound condition fresh food, to take the place as far as possible of tinned rations. Through the agency of an Inspectorate of Messing and Economies, regular schools of cookery gave instruction to nearly 25,000 cooks, and careful measures were taken for the recovery of kitchen by-products. In August, 1918,

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over 860,000 lbs. of dripping were received from Armies and consigned to England, while the cash value of the by-products disposed of from all sources has exceeded £60,000 in a single month. Provision was made for baths, and a new Inspectorate supervised the running of Army laundries on up-to-date lines.

The Expeditionary Force Canteens made it possible to obtain additional comforts close up to the front. During 1918, the value of the weekly sales in the different canteens averaged 8½ million francs. These canteens were valuably supplemented by the various voluntary institutions ministering to the comfort and recreation of our troops, such as the Y.M.C.A., the Church Army, the Scottish Churches Huts, the Salvation Army, the Soldiers' Christian Association, the Catholic Women's League and Club Huts, the United Army and Navy Board, the Wesleyan Soldiers' Institute, and the British Soldiers' Institute. In many cases these organizations carried on their work almost in the actual fighting line, and did much to maintain the high moral of our Armies. To permit the troops to avail themselves of the opportunities so offered, methods devised by the Paymaster-in-Chief enabled soldiers to obtain money anywhere in the Field. Parcels and letters from home have been delivered by the Army Postal Service with remarkable regularity.

As the effects of the enemy submarine warfare began to be felt and the shortage of shipping became more and more acute, so it became increasingly necessary for the Army in France to be more self-supporting. To meet this emergency vast hospitals and convalescent depôts capable of accommodating over 22,000 men were erected west of the Seine at Trouville. Additional General Hospitals with accommodation for over 7,000 patients were established in the neighbourhood of Boulogne, Etaples, and elsewhere. Between January, 1916, and November, 1918, the total capacity of hospitals and convalescent depôts in France grew from under 44,000 to over 157,000 persons.

Great installations were set up for the manufacture of gun parts and articles of like nature, for the repair of damaged material as well as for the utilization of the vast quantities of articles of all kinds collected from the battlefields by the organization working under the direction of the Controller of Salvage. The Forestry Directorate, controlling over 70 Canadian and other Forestry Companies, worked forests all over France, in the North-West, Central and South-West Departments, the Vosges, Jura, and Bordeaux country. As the result of its work our Armies were made practically independent of overseas imported timber. The Directorate of Agricultural Production organized farm and garden enterprises for the local supply of vegetables, harvested the crops abandoned by the enemy in his retreat, and commenced the reclamation of the devastated area.

At the same time, a great saving of shipping was effected by the speeding up of the work at the docks. The average tonnage discharged per hour in port rose from 12½ tons in January, 1917, to 34½ tons in July, 1918; while the average number of days lost by ships waiting berth at the ports fell from some 90 ship days per week at the beginning of 1917 to about nine ship days per week in 1918.

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For the accommodation of so wide a range of services, installations of all kinds, hutments, factories, workshops, storage for ammunition, clothing, meat and petrol, power houses and pumping stations, camps and hospitals, had to be planned and constructed by the Directorate of Works. Our business relations with the French, the obtaining of sites and buildings, called for the establishment of a Directorate of Hirings and Requisitions; while my Financial Adviser in France assisted in the adjustment of financial questions connected with the use of French railways and harbours, the exploitation of French forests and similar matters. The safe-guarding from fire of the great number of buildings erected or taken over by us and of the masses of accumulated stores was entrusted to a definite Staff under the supervision of a Fire Expert.

The creation and maintenance of the great organization briefly outlined above made big demands upon our available supply of *personnel*. Though these demands so far as possible were met, under the supervision of the Controller of Labour, by imported labour or prisoners of war, it was not practicable at any time to supply more than a proportion of our needs in this manner. Many fit men who might otherwise have reinforced the fighting line had also to be employed, especially during the earlier stages of the war.

As, however, our organization arrived at a greater state of completion and its working became smooth, so it began to be possible to withdraw considerable numbers of fit men from the rearward services. In many cases it was possible, where replacement was necessary, to fill the places of the fit men so withdrawn by women or unfit men. In this way, when the man-power situation became acute a considerable saving was effected. During the great British attacks of 1918, of a total male feeding strength of a little over $2\frac{1}{4}$ millions $1\frac{1}{2}$ millions were in front of railhead. Even so, as has been found to be the case in the Armies of all other belligerents, so in our Army the number of fit men employed in the rearward services has at all times been large, and necessarily so.

It is hardly too much to assert that, however seemingly extravagant in men and money, no system of supply except the most perfect should ever be contemplated. To give a single example, unless our supply services had been fully efficient the great advance carried out by our Armies during the autumn of last year could not have been achieved.

Wars may be won or lost by the standard of health and moral of the opposing forces. Moral depends to a very large extent upon the feeding and general well-being of the troops. Badly supplied troops will invariably be low in moral, and an Army ravaged by disease ceases to be a fighting force. The feeding and health of the fighting forces are dependent upon the rearward services, and so it may be argued that with the rearward services rests victory or defeat. In our case we can justly say that our supply system has been developed into one of the most perfect in the world.

(20) The preceding paragraph illustrates the demands which the conduct of operations made on the Staff and Directorates controlled by the Quartermaster-General. The parallel development of the Adjutant-General's Branch, while concerned with matters less patent to the casual observer, has been no less remarkable. The problem of ensuring

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the supply of reinforcements at the times and places at which they will be required to replace casualties is present in all warfare, and is difficult in any circumstances. In operations conducted on the scale reached in this war it is exceedingly intricate. The successful solution of this problem alone entitles the Adjutant-General and his Staff to the greatest credit. It has formed, however, but a small part of their work.

Owing to the impossibility of foretelling what claims would be made on man-power by industry or by other theatres of war, it was necessary to prepare elaborate forecasts of the *personnel* likely to be required at various dates, and to work out in advance the best manner of utilizing reinforcements in the event of their being available in greater or less numbers. We were faced with an unexpected contraction in man-power in the winter of 1917 and an unexpected expansion in the summer of 1918. Both these developments were encountered with a success which could only have been attained by the greatest forethought and application on the part of the Staff concerned.

To reduce to cadre a depleted Division, to fill it up when men became available, to break up a battalion and redistribute its *personnel*, to comb out a certain number of fit men from the rearward services, all sound simple operations. In reality each requires an immense amount of sympathetic treatment and clerical labour, the extent of the work involved being instanced by the fact that in the month of April, 1918, over 200,000 reinforcements were sent up to the fighting forces. The carrying out of measures of this nature was made more difficult by the continual formation of new types of unit to meet new requirements. It was necessary to find the *personnel* for those units with the least possible dislocation elsewhere, and with an eye to the most advantageous employment of the individual in regard to his medical category and special qualifications. The following figures will give some indication of the magnitude of the task. The Adjutant-General's office at the Base has prepared over eight million records containing the military history of individual soldiers in France, and has received and dispatched over 22 million letters.

Whatever the quality of the troops, a just and efficient administration of military law is an indispensable adjunct to a high standard of discipline. I gratefully acknowledge the care with which officers of the Adjutant-General's Branch in all formations have ensured the observation of every safeguard which our law provides against injustice. They have seen to it that every plea which an accused or convicted soldier wishes to bring forward is heard, and that Commanders are advised as to the suitability of sentences. I take this opportunity of recording my satisfaction at the success which has attended the operation of the Suspension of Sentences Act. The number of men under suspended sentence who by good conduct and gallant service in the field have earned remission of their sentence has been most encouraging.

Closely related to the administration of military law is the work of the military police under the Provost Marshal, and of the military prisons in the field. In the battle zone, where frequently they had to do duty in exposed positions under heavy fire and suffered severe casualties, the military police solved an important part of the problem

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of traffic control, by preventing the unavoidable congestion of troops and transport on roads in the vicinity of active operations from degenerating into confusion. In back areas, their vigilance and zeal have largely contributed to the good relations maintained between our troops and the civilian population.

Although the number of soldiers undergoing sentences of imprisonment in France has at no time amounted to 1 per thousand, the size of the Army has necessitated a considerable expansion of the Military Prisons in the field. The Director of Military Prisons, his Governors and warders have sought, not retribution, but to build up the self-discipline of the prisoner. They have been rewarded by seeing a large percentage of the men committed to their charge subsequently recover their characters as good soldiers.

Under the general control of the Adjutant-General, the Base Stationery Depôt, which went to France in 1914 with a *personnel* of ten, has expanded into the Directorate of Army Printing and Stationery Services, employing over 60 officers and 850 other ranks. In addition to the printing and distribution of orders and instructions, it undertook the reproduction on a vast scale of aerial and other photographs, the number of which grew from 25,000 in 1916 to two and a quarter million in 1918. Other examples of administrative success are the Prisoners of War Section and the Directorate of Graves Registration and Enquiries.

Of the care taken for the physical and moral welfare of the troops I cannot speak too highly.

In the former domain, the achievements of the Director-General of Medical Services and his subordinates have been so fully recorded by me in previous dispatches that they need no further emphasis. It is sufficient to say that, in spite of the numbers dealt with, there has been no war in which the resources of science have been utilized so generously and successfully for the prevention of disease, or for the quick evacuation and careful tending of the sick and wounded.

In the latter sphere, the devoted efforts of the Army Chaplains of all denominations have contributed incalculably to the building up of the indomitable spirit of the Army. As the result of their teaching, all ranks came to know and more fully understand the great and noble objects for which they were fighting.

Under the immediate direction of the Adjutant-General in matters concerning military administration, the Principal Chaplain for members of all Churches except the Church of England, and the Deputy Chaplain-General for members of the Church of England administer to the greatest harmony a very complete joint organization. Provided with a definite establishment for armies, corps, and divisions, as well as for the principal base ports, base camps, hospitals, and certain other units, they ensure that the benefit of religion is brought within the reach of every soldier.

In all the senior offices of this joint organization, down to divisions, the Principal Chaplain and Deputy Chaplain-General have each their representatives, the appointments to those offices in the Principal Chaplain's section being apportioned between the different Churches, Protestant and Roman Catholic, in proportion to the numbers of their following in the Army as a whole. This organization has worked for

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the common good in a manner wholly admirable and with a most noteworthy absence of friction. It has undoubtedly been much assisted, both in its internal economy and in its relations with commanders and troops, by being at all times in direct touch with the Adjutant-General's Branch.

No survey of the features of the war would be complete without some reference to the part played by women serving with the British Armies in France. Grouped also under the Adjutant-General's Branch of the General Staff, Queen Alexandra's Imperial Military Nursing Service, the Nursing Sisters of the Canadian Army Medical Corps and of the Australian, New Zealand, South African, and Territorial Force Nursing Services and the British Red Cross Society have maintained and embellished a fine tradition of loyalty and efficiency. These services have been reinforced by members of Voluntary Aid Detachments from the British Isles, the Oversea Dominions, and the United States of America, who have vied with their professional sisters in cheerfully enduring fatigue in times of stress and gallantly facing danger and death.

Women in the British Red Cross Society and other organizations have driven ambulances throughout the war, undeterred by discomfort and hardship. Women have ministered to the comfort of the troops in huts and canteens. Finally, Queen Mary's Auxiliary Army Corps, recruited on a wider basis, responded with enthusiasm to the call for drafts, and by the aid they gave to our declining man power contributed materially to the success of our arms.

(21) The experience gained in this war alone, without the study and practice of lessons learned from other campaigns, could not have sufficed to meet the ever-changing tactics which have characterized the fighting. There was required also the sound basis of military knowledge supplied by our Training Manuals and Staff Colleges.

The principles of command, Staff work, and organization elaborated before the war have stood the test imposed upon them and are sound. The militarily educated officer has counted for much, and the good work done by our Staff Colleges during the past 30 years has had an important influence upon the successful issue of the war. In solving the various strategic and tactical problems with which we have been faced, in determining principles of training and handling of troops and in the control and elaboration of Army organization generally, the knowledge acquired by previous study and application has been invaluable. Added to this have been the efficiency and smoothness of working resulting from standardization of principles, assisted in many cases by the previous personal acquaintance at the Staff College of those called upon to work together in the field.

The course of the war has brought out very clearly the value of an efficient and well-trained High Command, in which I include not merely commanders of higher formations, but their Staffs also.

This has been the first time in our history that commanders have had to be provided for such large forces. Before the war, no one of our generals had commanded even an Army Corps such as has been used as a subsidiary formation in the battles of the last few years. In consequence, commanders have been faced with problems very different to those

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presented by the small units with which they had been accustomed to train in peace. That they exercised their commands with such success as most of them did shows, I venture to think, that their prior training was based on sound principles and conducted on practical lines.

Similarly as regards the Staff, the magnitude of our operations introduced a situation for which no precedent existed. The Staff Colleges had only produced a reserve of Staff officers adequate to the needs of our Army on a peace footing, and for the mobilization of the Expeditionary Force of six divisions. Consequently, on the expansion of the Army during the war many officers had to be recruited for Staff appointments—from good regular officers chiefly, but also from officers of our new Armies—and trained for the new duties required of them. Though numbers of excellent Staff officers were provided in this way, it was found as a general rule that the relative efficiency in Staff duties of men who had passed through the Staff colleges, as compared with men who had not had that advantage, was unquestionably greater.

Good Staff work is an essential to success in all wars, and particularly in a struggle of such magnitude as that through which we had just passed. No small part of the difficulty of achieving it lies in the possibility that officers on the Staff of higher formations may get out of touch with the fighting forces, and so lose sense of proportion and become unpractical. Every endeavour was made to avoid this by maintaining a constant interchange of such officers with others from the front, so that all might keep abreast with the latest ideas and experience both in the fighting line and elsewhere. In pursuance of this principle, in addition to 18 officers from Army or Corps Staffs and other officers from the Intelligence Corps or General List, there were brought in during the period of my command some 50 officers direct from active duty with divisions or smaller units to hold for longer or shorter periods appointments in the General Staff branch at G.H.Q.

It may be accepted as a general rule that previous organization should be upset as little as possible in war. As each war has certain special conditions, so some modification of existing ideas and practices will be necessary, but if our principles are sound these will be few and unimportant. In the present war, new organizations and establishments for dealing with the demands of both the fighting and the rearward services have been brought into being continually, and added to or absorbed by our existing organization and establishment.

The constant birth of new ideas has demanded the exercise of the greatest care, not only to ensure that no device or suggestion of real value should be overlooked or discouraged, but also to regulate the enthusiasm of the specialist and prevent each new development assuming dimensions out of proportion to its real value. As the result of our own experience and that of the French during the fighting of 1915, all kinds of trench weapons were invented, bombs, bomb throwers, mortars, and even such instruments as trench daggers. In those days the opinion was freely expressed that the war would be finished in the trenches and every effort was made to win victories in the trenches themselves. In consequence, rifle shooting was forgotten and was fast becoming a lost art. Similarly as regards artillery, the idea of dominating and

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defeating the hostile artillery before proceeding to the infantry attack was considered an impossibility.

Then followed the experience of the battle of the Somme in 1916, which showed that the principles of our pre-war training were as sound as ever. That autumn a revival of old methods was inaugurated. Musketry shooting was everywhere carried out, and bayonet fighting was taught as the really certain way of gaining supremacy in hand-to-hand fighting. At the same time, as pointed out in paragraph 17 above, the greatest care was devoted to artillery shooting, as well as to the training of all arms for open fighting. The events of the next two years fully confirmed the lessons drawn from the battle of the Somme. In short, the longer the war has lasted the more emphatically has it been realized that our original organization and training were based on correct principles. The danger of altering them too much, to deal with some temporary phase, has been greater than the risk of adjusting them too little.

(22) Some idea of the extent of the organization built up during the war for the training of our Armies can be gathered from a survey of the different schools actually established.

In the Armies important schools were maintained for the instruction of officers and non-commissioned officers of infantry and artillery in their several duties, for training in scouting, observation and sniping, in the use of trench mortars, in signalling, musketry, and bayonet fighting, anti-gas precautions, mining, and defence against tanks. The different Corps controlled a similar series of schools. Added to these were the special schools of the Cavalry Corps, including a School of Equitation; the Tank Corps Mechanical School; and the different courses instituted and managed by divisions, which were largely attended whenever the battle situation permitted.

Other schools under the direct supervision of General Headquarters provided instruction in the machine gun, Lewis gun and light mortar, in anti-aircraft gunnery, in observation for artillery, in sound ranging and flash spotting, wireless, bridging and other engineering duties, in firing and bombing from aeroplanes, and in physical and recreational training. At the Base depôts big training and reinforcement camps were set up for infantry, artillery, cavalry, engineers, machine gunners, cyclists, Tank Corps, Signal and Gas *personnel*. Further, a regular succession of Staff officers and others were sent home to take part in the various schools and courses established in England.

In the course of the past year it was found desirable to make provision for the more thorough co-ordination of effort among these various schools, and also for assisting commanders, especially during battle periods, in the training and instruction of such troops as might from time to time be in reserve. For this purpose an Inspectorate of Training was established. Training and organization must always go hand-in-hand; for while tactical considerations dictate the organization of units and methods of training, upon sound tactical organization and training depend the development and effective employment of good tactics.

In the early spring of 1918 the foundations were laid of an educational scheme which might give officers and men throughout the Army an

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opportunity to prepare themselves for their return to civil life. Delayed in its application by the German offensive and the crowded events of the summer and autumn of that year, since the conclusion of the Armistice the scheme has been developed with most excellent results under the general direction of the training subsection of my General Staff branch, and generously supported in every possible way by the Educational Department at home. Divided into a general and a technical side every effort has been made both to give opportunities for the improvement of general knowledge and to enable trained men to "get their hands in" before returning to civil life. In this way between 400,000 and 500,000 persons have been brought under instruction, while the number of attendances at lectures has approached a million in the course of a month.

(23) The feature of the war which to the historian may well appear the most noteworthy is the creation of our new Armies.

To have built up successfully in the very midst of war a great new Army on a more than Continental scale, capable of beating the best troops of the strongest military nation of pre-war days, is an achievement of which the whole Empire may be proud. The total of over 327,000 German prisoners captured by us on the Western front is in striking contrast to the force of six divisions, comprising some 80,000 fighting men all told, with which we entered the war. That we should have been able to accomplish this stupendous task is due partly to the loyalty and devotion of our Allies and to the splendid work of the Royal Navy, but mainly to the wonderful spirit of the British race in all parts of the world.

Discipline has never had such a vindication in any war as in the present one, and it their discipline which most distinguishes our new Armies from all similarly created Armies of the past. At the outset the lack of deep-seated and instinctive discipline placed our new troops at a disadvantage compared with the methodically trained enemy. This disadvantage, however, was overcome, and during the last two years the discipline of all ranks of our new Armies, from whatever part of the Empire they have come, was excellent. Born from a widespread and intelligent appreciation of the magnitude of the issues at stake and a firm belief in the justice of our cause, it drew strength and permanence from a common-sense recognition of what discipline really means—from a general realization that true discipline demands as much from officers as from men, and that without mutual trust, understanding, and confidence on the part of all ranks the highest form of discipline is impossible.

Drawn from every sphere of life, from every profession, department, and industry of the British Empire, and thrust suddenly into a totally new situation full of unknown difficulties all ranks have devoted their lives and energies to the service of their country in the whole-hearted manner which the magnitude of the issues warranted. The policy of putting complete trust in subordinate commanders and of allowing them a free hand in the choice of means to attain their object has proved most successful. Young officers, whatever their previous education may have been, have learnt their duties with enthusiasm and speed, and have accepted their responsibilities unflinchingly.

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Our universities and public schools throughout the Empire have proved once more, as they have proved time and again in the past, that in the formation of character, which is the root of discipline, they have no rivals. Not that universities and public schools enjoy a monopoly of the qualities which make good officers. The life of the British Empire generally has proved sound under the severest tests, and while giving men whom it is an honour for any officer to command, has furnished officers of the highest standard from all ranks of society and all quarters of the world.

Promotion has been entirely by merit, and the highest appointments were open to the humblest provided he had the necessary qualifications of character, skill, and knowledge. Many instances could be quoted of men who from civil or comparatively humble occupations have risen to important commands. A schoolmaster, a lawyer, a taxicab driver, and an ex-Sergeant-Major have commanded brigades; one editor has commanded a division, and another held successfully the position of Senior Staff Officer to a Regular division; the under-cook of a Cambridge College, a clerk to the Metropolitan Water Board, an insurance clerk, an architect's assistant, and a police inspector became efficient General Staff Officers; a Mess Sergeant, a railway signalman, a coal miner, a market gardener, an assistant secretary to a haberdasher's company, a Quartermaster-Sergeant and many private soldiers have risen to command battalions; clerks have commanded batteries; a schoolmaster, a collier, the son of a blacksmith, an iron moulder, an instructor in tailoring, an assistant gas engineer, a grocer's assistant, as well as policemen, clerks, and privates, have commanded companies or acted as adjutants.

As a body, and with few exceptions, new officers have understood that the care of their men must be their first consideration, that their men's comforts and well-being should at all times come before their own, that without this they cannot expect to win the affection, confidence, loyalty, and obedience of those they are privileged to command, or to draw the best from them. Moreover, they have known how to profit by the experience of others, and in common with their men they have turned willingly to the members of the old Regular Army for instruction and guidance in all branches of their new way of life.

On their part, officers, non-commissioned officers, and men of the old Regular Army have risen to the demands made upon them in a manner equally marvellous. Their leaven has pervaded the whole of the mighty force which in 4½ years of war has gathered from all parts of the world round the small, highly trained Army with which we entered the war. The general absence of jealousy and the readiness to learn, which in the Field has markedly characterized all ranks of our new Armies, is proof both of the quality of our old Army and of the soundness of our pre-war training. If further proof were needed, it is found in the wonderful conduct and achievements of our Armies, new and old, and in the general pride with which they are universally regarded.

In the earlier stages of the war the Regular Army was called on to provide instructors and cadres round which the new Armies could be formed. All that was best in the old Regular Army, its discipline,

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based on force of character, leadership, and mutual respect, its traditions, and the spirit that never knows defeat have been the foundations on which the new Armies have been built up. Heavy demands were necessarily made upon our establishment of trained Regular officers, most regrettably depleted by the heavy sacrifices of the early days of the war. The way in which such demands have been met by those who survived those days has justified our belief in them.

Neither have the officers of the new Armies, whether drawn from the British Isles or the Dominions, risen with less spirit and success to the needs of the occasion. The great expansion of the Army, and the length of the war, necessitated an ever-increasing demand being made on them for filling responsible positions in command, staff, and administrative appointments. The call has been met most efficiently. The longer the war continued, the greater became the part played in it by the new Armies of the Empire.

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NOTICE OF MAGAZINE.

REVUE MILITAIRE SUISSE.

No. 1.—*January*, 1919.

(*Continued*).

THE BELGIAN VICTORY IN FLANDERS.

An account is given in the original article of the operations of the Belgian Army during the period 28th September—30th October, 1918.

July 18, 1918, will ever remain memorable in the history of the world; it was the date whereon the new strategy of Marshal Foch caused the tide to turn on the Western Front, whereby the wave of the Hun invasion was rolled back beyond the limits of the Rhine; on that day was launched the first of a series of pushes, on the extended battle line stretching from Amiens to St. Mihiel, pushes which eventually freed northern France and Belgium from the enemy after an occupation of four years and more.

Taken by surprise, the German High Command was now obliged to sacrifice a great part of the reserves and the élite of the German army, and, almost simultaneously, the opportunity was seized by the Entente troops to recommence active hostilities on the Flanders Front, whereon comparative calm had reigned since the great German push of April, 1918.

The Belgian Army, which had checked the enemy, on the 17th April, on the Merckhem front, inflicting terrible losses on him, had impatiently waited for the hour when it would be its turn to advance to the attack. When this hour arrived, the enthusiasm of Belgian troops enabled them to accomplish great deeds, the importance whereof is attested by the following events:—The recapture of the "Crête de Flandres"; the recrossing of the Yser; the re-occupation of the coast line.

On the 28th September, the Belgian Army and the 2nd British Army was launched to the attack on the front Dixmude to the Lys; three French Divisions and a Cavalry Corps were in support of the Belgian Army, and, a few days later, joined in the attack.

These combined forces formed a group of Armies under the immediate command of King Albert.

The operations, in which the Belgian Army took part, may be said to have consisted of two phases: the Battle of the "Crête de Flandres," which began on the 28th September and ended on the 4th October: a complete lull then occurred for the space of ten days, after which, on the 14th October, the troops were again launched to the attack and the "Battle of Thourout-Thielt" followed.

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A short account of the Battle of the " Crête de Flandres " is given in the original article ; it is illustrated by a sketch map whereon the six defensive lines successively taken up by the Germans, between Dixmude and Ypres, are marked. During the four years of their occupation of this region the Germans had done a great deal to strengthen the positions held by them. But, in spite of the obstinate defence put up by the invaders, they were driven out of these positions. Some 6,000 prisoners were taken, including about 100 officers ; further, 1,250 guns, 300 machine-guns and a great quantity of ammunition and stores were also captured by the Belgians during these operations. Between the 28th September and the 2nd October, nine German Divisions had successively attempted to oppose the advance of the Belgians, who, however, had now had their enthusiasm raised to so high a pitch by their first success that, in spite of their heavy losses, they were determined to punish the hated oppressors of their countrymen. The Belgians realized too that the liberation of their country was now in sight, and they therefore continued to push forward with added zest.

The Women's Army Auxiliary Corps.

The author of the original article points out that the generally accepted principle upon which the Swiss Army is recruited is based on the generalization that every Swiss is liable for military duty according to his aptitude and in such a sphere that the maximum effort can be developed by the nation in strategical and tactical operations. Similar principles apply in the recruiting of all armies, but nowhere has the principle been ever pushed to such extremes, it is said, than was recently the case in the British Army. In order to permit of the greatest effort in the fighting line, by putting every man fit to shoulder a rifle in the ranks, the British High Command has not hesitated to organize a Corps of Women.

The number of the *Revue de Paris* for 1st August, 1918, contains, it is pointed out, an interesting article on the W.A.A.C. by Mme. Andrée Viollis. A summary of the article in question is given in the number of the *Revue* under notice.

Notes and News.

Switzerland.—The Federal Chamber is still considering the question of reducing the military estimates. Apparently, one of the directions in which it is hoped to effect an economy is by the postponement of the embodiment of the recruits of the 1919 Class. The recruits of the 1918 Class, who had to be demobilized on account of the influenza, will, however, be called up to complete their course of instruction. It is suggested that the Army of the future should not be destroyed until there are sure grounds for the view that it will never be wanted. Europe, at the dawn of 1919, does not present the spectacle of being peopled by races in a frame of mind fit to bring into existence the organization known as the " League of Nations." Go slowly in the matter of military reform, is the advice given by the contributor of the original notes.

Attention is called to a brochure entitled *Wilson en Europe* recently published in Geneva ; it apparently contains an attack on all who are

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not prepared to accept unreservedly the proposal relating to the establishment of a "League of Nations." The "League of Nations," it is pointed out by the contributor of the original notes, will have to undertake police duties and, in consequence, an armed force of some kind will have to be maintained by it, since it may become necessary, as a last resort, to occupy the territories of a Power, should it prove impossible, in the future state of existence of the idealist, to determine a dispute or difference, in which such a Power is involved, by arbitration. History provides many examples of the manner in which the spirit of an international contract may be broken, whilst the letter thereof is strictly observed, *e.g.*, Prussia's agreement with Napoleon, after Jena in 1806, to the effect that she would only maintain a standing army of 30,000 men for the purposes of maintaining internal order; yet when the War of Independence began in 1813, she had in reserve seven classes of trained soldiers which were at once incorporated into her standing army. The most recent example of the worthlessness of international contracts lies in the repudiation by Germany of the provisions of the Hague Conventions, as soon as she realized that she had absolutely no chance of obtaining a complete and conclusive victory on the Western Front.

Switzerland's duty at the present time, says the contributor of the original notes, is to take care that, in military matters, the cart is not put before the horse. Pacifism is a magnificent ideal, but the moment it becomes morbid the result is war.

The present situation is that a formidable army, that of Germany, which menaced the world for years, has disappeared, and with it the military forces of Austria-Hungary, Turkey and Bulgaria. On the other hand, it is pointed out, Great Britain and the United States of America, which previous to 1914 were naval Powers only, now possess formidable armies also. Hence the tilt in the beam of the balance has been reversed, the Anglo-Saxon peace weighs heavier than the peace of defeated Germany. What has happened is that the dominating Power of yesterday has been replaced by that of the morrow; history repeats itself.

Colonel Schlappach has succeeded to the command of the Swiss 3rd Division *vice* Colonel Gertsch.

The number of the *Revue* under notice concludes with a Bibliography; particulars of a number of works on military subjects are given therein, including Colonel Feyler's recent work *Le problème de la guerre.*

No. 2.—February, 1919.

THE NEED FOR MAINTAINING AN ARMY IN SWITZERLAND.

The original article is contributed by Colonel C. Sarasin, Commander of the Swiss 5th Infantry Brigade, who points out that the Swiss Army is passing through a critical era in its existence. Those who are attacking it, he points out, see in the Swiss Army an instrument essential to the maintenance of good order in the State; the last thing desired by the calumniators of the army. The real danger arising out of the present situation is the effect that the agitation is likely to have on the minds of the young men in the Republic; the youth of Switzerland, Colonel

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Sarasin tells us, has to-day a totally different conception of its duty towards the defence of the State to that which prevailed in his boyhood. Anti-militarist theories are based on grounds which, to some extent no doubt, are idealistic, but the disinclination to serve in the army is due chiefly to the mischievous theory that every man should be free to choose for himself what authorities he shall obey and what calling in life he shall adopt. If human nature were perfect and altruism could be made to replace egoism in human relations, all armed forces would, Colonel Sarasin points out, become superfluous. But in spite of all the talk about the formation of a League of Nations, the human race has still to journey thousands of leagues before it can enter the ideal world. Colonel Sarasin is of opinion that in a democratic country such as Switzerland, it is impossible to think of civic duty as something apart from military duty He urges that Switzerland shall not only continue to maintain her army, but that this army shall be made fully capable of carrying out all the duties likely to be imposed upon it.

Colonel Sarasin suggests that if the Government considers it necessary to cut down military expenditure, the best way of doing so would be to reduce the establishments of the " first line troops " by eliminating from the battalions that which is of smallest value ; he further recommends, in effect, that the infantry battalion should consist of three companies and a M.G. detachment.

The importance of military training is touched upon in the original article, and it is urged that the value of the experiences gained during the mobilization of the Swiss army from August, 1914, to December, 1918, should not be lost sight of. The best equipped army, it is pointed out, is worthless unless it is at the same time well trained.

Attention is called to an article in the *Schweizerische Militärzeitung* (No. 43, of 1917). It is stated in the article in queston, *as a regrettable fact*, that the subaltern officers of the Swiss army do not possess the qualities required in the leaders of men. Colonel Sarasin is of opinion that although matters have recently improved considerably in the leadership shown by officers, there is still much room for improvement ; he gives his views as to the directions in which remedies can be applied.

The deficiences of the N.C.Os. are also dealt with in the original article and suggestions are made for improving their position and prospects.—(*To be continued.*)

The Belgian Victory in Flanders.

The article on the above subject begun in the number of the *Revue* for January, 1919, is continued. An account is given of the Battle of Thourout-Thielt ; a sketch map being provided whereon are marked the successive positions taken up by the Belgian Army between September 28th and October 18th, 1918.

It is pointed out that after the serious defeat which the German army experienced during the last days of September, 1918, when it was driven out of the strong positions held by it on the Crête de Flandres, it sought refuge in the Flandern I Stellung covering Roulers, a position which had been prepared for defence long beforehand. The Belgian

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General Staff realised on October 2nd that the enemy had made arrangements to defend the Flandern I Stellung *à outrance* and it had, in consequence, issued the necessary orders for the massing of troops, particularly of artillery, for a fresh general attack. As a preliminary measure it became necessary to re-establish communications by road and rail in this devastated region, since the enemy, as soon as hi retreat began, had destroyed most thoroughly all roads and railways in this locality. The troops had now to begin a fight against the Flanders mud which rendered movements of all kinds extremely slow and painful. Thanks to the efforts of the engineers and the labour battalions, railways were once more restored, roads began to come into existence, bridges were constructed over rivers, canals and even shell-holes. The prodigious efforts and untiring zeal of the troops of all arms produced within a few days most remarkable results.

The work on communications which had to be carried out rendered it necessary to postpone the date for opening the second battle for the liberation of Flanders, to October 14th. The success of the Entente troops in the Battle of Thorout-Thielt was so complete that the enemy had at last to give up possession of the Belgian coast and retired westward, thus freeing the whole of Northern Flanders and a great part of Eastern Flanders.

In the original article an outline is given of the general scheme of the Battle of Thourout-Thielt ; the events thereof are related under the several dates, October 14th to October 19th ; the narrative being brought to a close with a brief reference to the final operations which began on October 20th and ended on November 11th—the date on which the armistice was signed.

The Defeat of the German Army.

The original article on the above subject is contributed by Colonel Feyler, who directs attention to a curious discussion which has been taking place in military circles in Switzerland. The discussion seems to have started owing to the opinion having been expressed that " at the date of armistice, November 11th, 1918, the German army had been beaten *morally*, but not technically."

" This debate," writes Colonel Feyler, " contains matter of greater interest than does the quarrel of the Byzantine coachmen, although from the practical standpoint, there is as little real sense in it."

It is pointed out in the the original article that subtle distinctions in the degree and quality of a defeat possess no practical value. The aim of strategy is to compel an enemy to bow to his adversary's will ; that is to say, to cause an enemy to accept unconditionally the measures dictated to him by his adversary and to conform to the same When beaten generals are reduced to accepting a situation imposed by the will of their adversary, it matters little what may be the extent and quality of the technical resources still in the possession or at the disposal of their army. They renounce, by the acceptance of their adversary's terms, the use of such resources, which they virtually admit have lost all military value.

Many instances are recorded in history of armies which, although

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still capable of fighting, have laid down their arms at the bidding of their generals. But it does not follow that generals who take so extreme a step as to surrender are either traitors or incompetent or immoral. Colonel Feyler gives his views as to the probable meaning of the expressions "*not technically* beaten"; it applies, he thinks, to an army which is still in possession of the means which enable it to manœuvre with sufficient freedom to ward off immediate defeat or surrender. He explains that if his assumption as to the meaning of the expression "not technically beaten" is correct, *i.e.*, that which its authors intend it to convey, very few armies have suffered defeat either in the Great European War or in the long history of the Wars of past ages. He deals with the various operations of the Great War and points out that, if his interpretation of the expression in question is correct, only the armies of Samsonoff and Rennenkampf in East Prussia and the Ottoman hosts, in Palestine, have really suffered defeat. The subtleties in the distinctions which the authors of the phrase "not technically beaten" wish to introduce in the quality of defeat, if generally accepted, would render it necessary for the whole of the military history of the world to be re-written; the Germans would have to be deprived of the credit given them for victories at Forbach, Rezonville, St. Privat, &c.; Napoleon I. could no longer be hailed as the victorious general of Austerlitz and Jena, &c.

Colonel Feyler points out the absurdity of the distinction which it is attempted to make between the *moral* and the *technical* defeat of an army He examines the situation which led the Germans to ask for an armistice in November and shows conclusively in what a hopeless condition the German armies were. At the date of the armistice, the Central Powers had only 17 divisions in reserve, of which two only were resting. On the other hand, the Entente and Associated Powers had 30 divisions in Lorraine, under the orders of Generals Mangin and Gérard, which could have been utilized for an attack east of the Meuse on November 14. In addition the American Third Army was ready to take its place in the front line. Warned that a French attack was imminent in Lorraine, the Germans had already ordered the evacuation of Metz and Thionville to begin on November 11. During the four months, July 18 to November 11, the Entente Powers had given the Germans battle on an extended scale on more than twenty occasions, and not in one of them had the latter scored a success. In view of the fact that to all outward appearances the German armies had up to this moment seemingly possessed solidity and resisting power and remained, in a technical sense, well organized their want of success was significant and is alone attributable to the excessive fatigue of the German soldier brought about by the undue strain put upon him.

The Germans had been obliged to surrender all the ground won by them in the first half of 1918 and were back again in the positions on which they had met the powerful attacks of their enemy for many long months in the earlier years of the war. It may be that the German High Command now made the serious mistake of staking everything on the *technical* equipment of its army. The Great General Staff did not dare to adopt the strategy which had proved so successful in the

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hands of Marshal Joffre, in 1914, when he took the bold course of temporarily abandoning Northern France and even giving up his second line of defence on the front La Fere—Laon—Rheims. It may be that the German leaders were afraid of their people; they perhaps realized that if the German military measures conformed to the requirements of the strategical situation the German nation would at last be undeceived and they probably foresaw the consequences.

The Germans made a further mistake in placing so much reliance on the strength of the "Hindenburg Line." A *resumé* of the operations which resulted in the Germans being driven out of their positions on the line Verdun—Rheims—Soissons—Lille—the coast west of Ostend, is given in the original article; three sketch maps accompany the text.

Colonel Feyler, in conclusion, points out that, in military matters, it is the fundamentals that alone count, the rest must be ignored. In the case of the Western Front, the chief feature of the situation was that the German army had been greatly reduced in numbers, equipment and *morale* by four months of retreat and continual defeat, so that its leaders could no longer count on manœuvring it into such a position as would enable them to ward off eventual defeat. A retreat to the Rhine would have probably involved the loss of a great part of the German army; to avoid this catastrophe, the German High Command had no other course open to it but to ask for an armistice, the terms of which, when made known, it was not in a position to resist and to which it, therefore, had to agree unconditionally.

NOTES AND NEWS.

Switzerland.—The military budget for 1919, as revised by the Federal Council, has been accepted by the Federal Council. The Swiss military budget for 1914 was approximately 9¼ million francs; that for 1919 amounts to 38½ million francs.

The question of the Swiss army of the future is discussed. To point a moral, it is stated that the exclusively insular and colonial policy which has prevailed in the British Isles for many centuries past, nearly ended in a disaster for the British nation; her Expeditionary Force of 1914 was quite inadequate to meet the situation of August, 1914. Thanks to the existence of the conscript army of France, time was gained and the British people were thus enabled to build up its new army. Switzerland should take the lesson to heart. Further, it is suggested that if Switzerland entered the League of Nations as a neutral State, it would be necessary for her to maintain an army proportionate, in relation to her means, to those of the other members of the League.

The present Chief of the Swiss General Staff, Colonel-Commandant de Sprecher is retiring from his post shortly. It is urged that his successor should be an officer who has the entire confidence of all sections of the Swiss army. It is recommended that a clean cut should be made with the old *régime*. ¶ The *Société des Officiers* in Berne have addressed a request to the *Comité Central de la Société des Officiers* for a meeting to be called for the purpose of drawing up a programme of subjects for discussion during the current year. The Lausanne sub-section of

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the *Société des Officiers* is supporting the request made from Berne. It would appear that the officers in Berne are interested more particularly in political questions such as disarmament, neutrality, compulsory service, etc., whilst those in Lausanne, on the other hand, desire precedence to be given to purely military questions, such as military training, education of officers, &c. These conflicting claims have to be adjusted.

Portugal.—A special correspondent states that the Portuguese troops which have been fighting on the Western Front are to form part of the "Army of Occupation" to be maintained by the Entente Powers in the Rhine provinces.

The Portuguese are much gratified by the visit of the British cruiser *Active* to the Tagus; they see in this visit a manifestation of the continuance of the ancient friendship of the two nations. During the war the Portuguese losses at sea, due to the U-boat warfare, amounted to two small ships of war, 33 steam-ships, 48 sailing-ships, and several fishing and coasting boats; representing in all a loss of 93,500 tons.

The first batch of Portuguese prisoners of war have been repatriated; they, like other prisoners, complain of the ill-treatment suffered by them at the hands of the Germans.

International News.—The contributor of the notes under this head points out that the diplomatic situation in Europe should clear up in March of this year, when it should become evident which nations are sincere in their desire for peace and which the nations are on whom peace must be forced. The armies of the Entente powers will, he says, have a quiet time during the winter, but the armies of the League of Nations should be ready for a campaign against the "recaltricants" in the coming spring-time.

The contributor of the notes classifies the "recaltricants" in three categories: (1) the Central Powers; however, their defeat was so serious that they are not likely to be a dangerous adversary next spring; (2) Russia and the several states which came into existence on her disruption; the attitude of the Russians towards the Entente, particularly in relations to the proposed meeting at Prinkipo, indicates that they prefer the present state of anarchy to continue rather than see peace restored in their country; and (3) malcontents in the camp of the Entente powers. There are people in the foregoing categories who, it is suggested, will only yield to force and the League of Nations must be prepared to act accordingly.

Arbitration, though a simple remedy in theory, is a most difficult one to put into practice. War as a mode of settling international quarrels is not likely, it is said, to be abolished as a result of the labours of the Paris Conference nor in the year of grace, 1919. There are, it is pointed out, approximately 40 millions of neutrals in Europe: Spaniards, Scandinavians, Dutch and Swiss; they have enjoyed the benefits of peace, but they have maintained and are maintaining armed forces, well equipped and well trained. It is suggested that the neutral powers should place their armies at the disposal of the League of Nations for the purpose of garrisoning the territorities, the possession of which is now being contested at the Peace Conference.

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No. 3.—March, 1919.

THE NEED FOR MAINTAINING AN ARMY IN SWITZERLAND.

The article by Colonel Sarasin on the above subject begun in the February number of the *Revue* is concluded in the number under notice. The training and education of the man in the ranks is dealt with in this part of the article. Colonel Sarasin states that in order to decide what is the best kind of training which should be provided for the soldier, it is first necessary to ask one's self: what are the qualities looked for in the soldier? He sets out, under five heads, his answer to this question, as follows: (1) A soldier should be loyal, well-disciplined and brave: (2) he should possess habits of orderliness, cleanliness and smartness; (3) he should be strong and active; capable of making long marches, of getting over obstacles and of throwing hand grenades to a good distance and with accuracy; (4) he should be a good marksman; and (5) he should be a man of intelligence, capable of acting on his own initiative, whenever engaged on detached duties or under circumstances requiring personal decisions.

The time available for obtaining the multiple results stated above are, says Colonel Sarasin, all too short, and therefore the best use must be made of it. Of the five heads enumerated, which constitute the indispensable qualifications of a soldier, particularly that of the infantryman, the first two are essentially dependent upon the moral qualities of the man.

Colonel Sarasin deals with the rôle which officers, particularly the subalterns, ought to play in developing the soldiers' moral qualities. The subjects of drill, gymnastics, bayonet exercises, rifle practice and the part each should play in the training of the soldier are touched upon in the original article.

In conclusion, Colonel Sarasin expresses the opinion that (1) the Swiss National Army should be recruited on the basis of *compulsory* military service; it is the duty of the heads of the Republic to make the necessary provision for the proper training of such an army and of finding it in up-to-date arms and equipment; (2) an absolute necessity exists for increasing the personal authority of officers of all grades over the rank and file; in consequence, officers must be more closely associated with the training of their men than heretofore; (3) the selection of men for non-commissioned rank and their training subsequent to appointment should be left to a greater extent than at present in the hands of the officers commanding the various units; and (4) the methods of training recruits and the men in the ranks should be entirely remodelled; every element of a vexatious nature should be entirely eliminated from the scheme of training.

Colonel Sarasin urges that every officer and every military society or institution in Switzerland should interest himself or itself in the great patriotic work of bringing about reforms which are urgently wanted in the Swiss Army.

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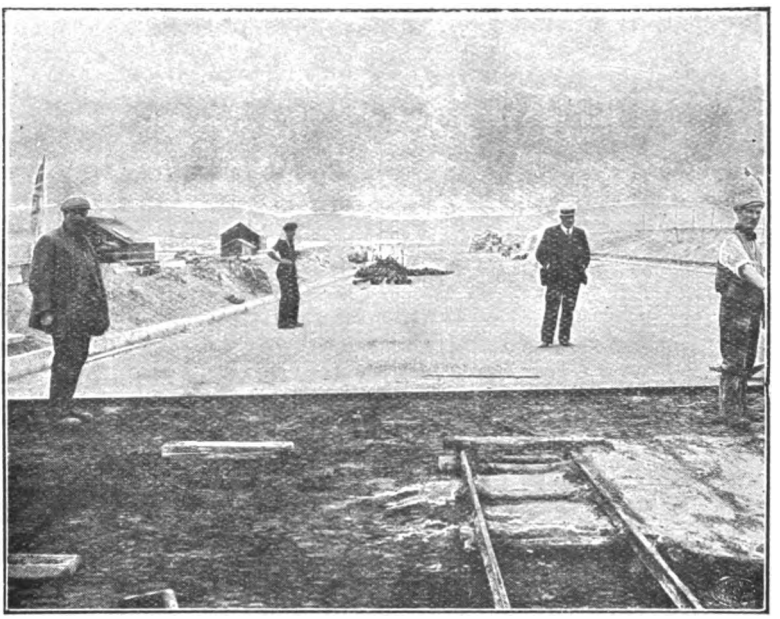

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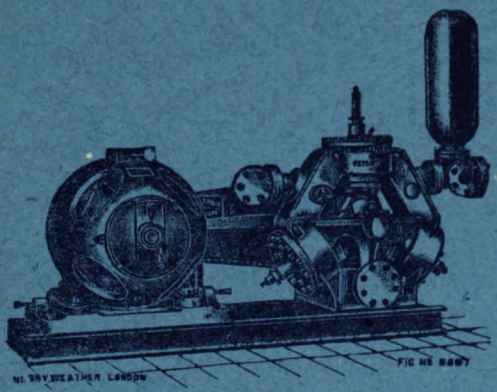

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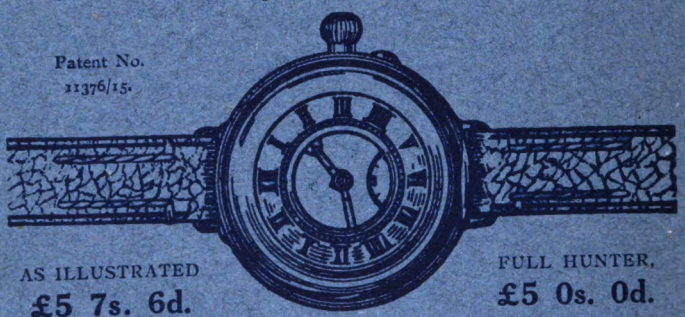

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NOTES ON TRENCH WAR.

By MAJOR H. A. S. PRESSEY, M.C., R.E.

(*a*). Trench war was evolved in the winter of 1914–1915, due to the fact that the Germans were treating the war as a battle in which they were holding a line on the Western Front, while attacking on the Eastern Front. The French and English were not capable of attacking. Original trench systems in the English line were based on the principles of *Field Service Regulations* and, with a large modicum of trained officers, proved extremely effective, *e.g.*, a German brochure on the British lines in the Ypres salient, published after our withdrawal consequent on the gas attack of 1915, holds the siting and tactics of our trenches up as a model to be followed, and laid down that in their systems, too much attention had been paid to detail and too little to principle.

Untrained officers, and officers obsessed by the detail of trench war, then regarded defensive systems as a means to an end. Trenches made as a means of covered communication between posts came to be looked on as defensive lines, the obsession of the hand grenade came in and caused the neglect of the rifle.

The necessity of upkeep of elaborate trench systems together with the inherent antipathy to manual work of the British nation necessitated the keeping of large garrisons in trenches. This necessitated provision of a large amount of accommodation. Owing to the increase in artillery this accommodation had to be provided in the shape of bomb proofs, and fortification became more elaborate and to be regarded as a means to an end.

(*b*). Further experience gained in attacking trench systems, which had been elaborated on the same style as our own, much the same result being obtained though, due to the fact the German is a harder worker than the Britisher, with a much greater economy of men, led to a return to the principles of *F.S.R.*; but, owing to the lack of experience and knowledge of officers and natural reaction taking the swing of the pendulum back too far, this led to a system easily penetrated.

(*c*). The ideal to be aimed at is that laid down in *F.S.R.* and the *Manuals of Field Engineering* modified to suit the altered conditions, due to the enormous increase in the amount of artillery employed in modern battles and the lack of initiative, which is a necessary

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adjunct of partly-trained officers and men. Owing to the fact that this system must be held in all weathers and at all times, the siting of the works necessary must conform to those laid down for night dispositions.

(*d*). The only object of Field Fortification is to husband men. Skilfully designed works enable large areas to be held with small numbers of men, thus enabling a weaker force to hold back a stronger, and freeing larger numbers of men to develop an offensive, and by the offensive alone can any decisive result be obtained.

(*e*). The essential spirit of a good defensive is the offensive. Defences must be designed to develop to the full the possibilities of final counter attack, and to foster the offensive spirit in the defenders.

(*f*). Artillery has increased to an extent both in number and power undreamt of by the masters of war previous to this age. It has now reached a pitch where its actual is equal to its moral effect, and, fully developed, its power is superior to that of the rifle. Hence the necessity of securing good observation and the consequent seeming objectives of the battles of this war. In this particular it should be noted that certain battles must not be quoted as examples. They were only in the nature of local operations in the general scheme to obtain a local advantage and as preliminaries to a greater scheme. The May offensives in 1915, called the battle for the Aubers Ridge, had originally the definite idea of a break through, afterwards modified to the fight for a limited objective, when that was no longer seen to be possible. The attack on the Vimy Ridge in 1917 was to provide a strong defensive flank to a break through further south. Lorette Ridge was contemporary with the Aubers Ridge attack, and had at the outset the same object; it was the same with the Chemin des Dames battle in 1917.

Messines Ridge was a preliminary objective of the battle of the 31st July. The fight for Passchendaele Ridge was to give the British a good jumping off ground for an offensive in the Spring of 1918. The gaining of Mount Kemmel is a distinctive case in point; it did not lead as was expected by short-sighted people to any result that was in the slightest decisive. St. Quentin was a preliminary objective in the turning of the German position on the Somme. In fact it is necessary for the full development of artillery to obtain good observation. This, however, is not so essential to Allies with their mastery of the air as it is to the enemy. It is absolutely essential that the strategical and tactical sighting of lines must not give way to the obsession of observation. Good communication and husbanding of men are the necessaries to be borne in mind. Remember the enemy has never expended large numbers of men and material in trying to obtain observation. His offensives have always been made with a much greater objective. Other things being equal, observation is the deciding point. Generally speaking

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communications are so good in this country that observation looms largely in any defensive scheme but it must be relegated to its proper position. Denial of observation to the enemy is of importance as well as observation on your own side. It is to be remembered that the nastiest knock to any troops is that, having spent men and material on capturing a place, they find another and bloodier beyond. That was the weak point of the Hindenburg line. Observation is undeniably a very important point, but it is not the only one.

(*g*). The choice of defensive lines and the general siting is well understood, much is written on it and all to the point. G.H.Q. instructions on this point are clear and complete. It is in the particular siting that much is to be improved. The principles are laid down in *F.S.R.* It is to be remembered that the defensive works should be sited so as to enable night dispositions for outpost lines to be put into force as regards the forward lines, and the main or battle lines be arranged as laid down in these regulations.

(*h*). Depth is a term that is much misunderstood and much discussed. It is perhaps the most abused word in the military vocabulary at the present moment. It must be understood that there is disposition in depth, but what is mostly achieved in existing defensive systems is dispersal in depth. Any system which allows of its lines being successively disposed of by the enemy is wasteful and inherently faulty and must be condemned. When a Unit is so disposed that it can readily present a reinforceable front in any direction, it is disposed in depth. Double echelon is perhaps the best disposal in depth that can be imagined.

(*k*). The power of appreciating a situation is at the present moment moribund, in all except perhaps the higher commands. Could the term " appreciation of a situation " be but substituted for " depth " as a popular catchword much improvement might be made in the present systems erected.

(*l*). Coming particularly to rear defence lines, which are intended to check the advance of a victorious enemy which has broken the field armies in their front and is engaged in a pursuit, the essential points are that they must be capable of being held by a thin nucleus garrison, and that they form a rallying line for the defeated troops who are coming back, on which these troops can be reorganized, and they can readily hold in a formation which is not organized. In this system the nucleus garrisons occupy the position of the outposts in ordinary terms of the word. They check the advance of the advanced guard of the enemy, and allow the main force, which is retreating disorganized, to reform behind them and deploy into the battle zone. For this purpose they must be capable of offering a resistance to the first attacks of the enemy unaided or with such aid as can be rendered by the small organized bodies of the retreating

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troops. The alignment of their defences must be in advance of the ground on which it is intended to fight the main battle, as the retreating armies can only be rallied and reorganized in any efficient way when they are free from enemy action. The positions must have depth, or a successful attack on any one point will lead to the giving away of the whole system. In the design and siting of the positions great attention need not be paid to the action of enemy artillery, as the enemy will not be able to develop much of his artillery power for some length of time. In the same way he will not be able to resort to the effective use of gas, so special localities susceptible to gas need not be avoided. Special mention is made of these points, as the great resisting power of villages in the absence of effective artillery, and of woods, in the absence of gas, should be developed to the utmost extent. At the same time alternative positions should be prepared in the case of these places, as the enemy, by concentrating his available resources on special points, may be able to make such localities untenable by the use of either of the above mentioned auxiliaries.

(*m*). Acting on the above conclusions, and having decided on the main line which it is essential to hold, the covering or outpost line must be immediately proceeded with. This line would, at the same time as fulfilling the above purpose, also serve as the outpost line for the main position, when matters are restored to a more stable status. In the design of the works it must at all times be borne in mind that extra trenches must be eliminated. Complicated systems lead to expense in garrisons and to dispersal of men. Men so disposed that they cannot be of service at the critical moment are men wasted. Successive lines of defence have the disadvantage of dispersing men in depth, while at the same time dispersal of men in a line renders that line weak and of no account. The limitations of the half-trained soldier should be borne in mind and the lack of initiative of the present day man allowed for. The action of an advancing enemy must be taken into account. He will be advancing with an out-thrown advanced guard in pursuit. His leading troops should act with boldness and, on meeting a check, the first attacks will be in the nature of reconnoitring thrusts. On the nature of the resistance with which these thrusts meet, will depend the action of the supporting parties. These, on being held up on a line, will proceed with vigorous action against those points which will give them an advantage; the first frontal attacks failing, they will endeavour to penetrate at weak points and advance by turning the offending localities. The object of the defence will be to check him on the line and deny him access to those points which would lead to a crumbling away of the system. This leads to the necessity for more strongly holding these points and the watching of the ground between. Owing to the paucity of the men available for this preliminary defence, the defence should be so arranged that the eli-

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mination of one or more of these points is necessary before the attacker can make a successful advance against the weakly held curtain between. The great trap to be avoided is to have a system by which the defenders sit on the hill tops, whilst the attackers march practically unopposed up the valleys, or the opposite fallacy of holding the valleys and allowing the attacker access to the hill tops, the possession of which will lead to a hurried retreat of the low-lying garrisons. But care must be taken not to fall between two stools by attempting to be strong everywhere, thus spreading the available troops and thinning the line to a breaking point over the whole front. Obstacles are erected with the purpose of helping the defender to develop to a maximum the weapons at his disposal. Normally speaking these are the rifle, the machine and Lewis guns, and the field gun. The distinct object of an obstacle is to delay the attacker where these arms can exact their full toll of him. The presence of an efficient obstacle has again and again, when used in combination with these arms, proved decisive. The design of an obstacle must conform to the local conditions. Probably the most efficient form intact is the broad belt of thick barbed wire. The development of modern artillery and the trench mortar has, however, rendered this form of obstacle easy to deal with. The form of obstacle which is at the moment considered effective, takes the form of barbed wire fences erected one behind another and running obliquely. The advantages claimed for this form are that it is not so conspicuous to aircraft observation and photography, covering a large area it is not so susceptible to artillery fire, though perhaps easier to negotiate by small highly trained parties of infantry, it is probably as efficient, as an obstacle, as the other types tried. It will be tried in the course of time, but at the present date the prevailing fashion in this respect seems fundamentally sound. It is probably most efficient when combined with belts of wire entanglement spaced at 30 to 40 yards distance. But in the design of an obstacle it must be remembered that it does not take the place of an efficient sentry, but merely aids him. It is not to keep out individuals or even small parties of the enemy, but to delay his formed bodies, break up their dispositions and enable the defender to develop the use of his arms to the maximum extent. The actual siting of an obstacle is of the greatest importance. It should so check the enemy as to bring him under enfilade fire. To enable this to be done the trenches themselves must be sited with the position, tracing, and design of the obstacle in view. This brings in the siting of trenches. To avoid confusion the following terms will be employed in this paper, the *siting* of trenches as dealing with the general choice of positions, the *trace* of trenches as the alignment of trenches and their alterations in direction in connection with the other parts of the same trench, the *plan* of a trench as the actual form in plan of a trench in detail.

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In general in the trace of trenches the British excelled in the early days of the war, but now the trace of trenches in the British Army is on the whole exceedingly poor. In the early days junior ranks sited a length of trench to be held by a unit bearing in mind the proper development of their weapon, the rifle, the position of their neighbours and the way mutual aid should be given. These trenches were afterwards joined to facilitate communication. The result was exceedingly good. Now trenches are traced in continuous lines and correspondingly suffer. In the tracing of trenches the minimum number of men essential to hold a locality should be considered, also their disposition so that they can render mutual aid. The trenches they would be disposed in should then be sited and traced, and these sectors should then be joined by travel trenches on the same plan. The practice of starting at one end of a line with a bundle of flags in the morning and returning when the day's quota have been erected on the ground is to be deprecated. This leads to the tracing of a trench line generally far too straight and which would take an unnecessarily large number of men to hold. In this particular the organization of the infantry must be borne in mind. Generally speaking the infantry unit is a platoon which consists of 40 effective men on an average. These are organized as about thirty men whose primary arm is the rifle, and ten the Lewis gun, of which each platoon has two. Not being thoroughly up to date, my statement may not be quite accurate. There is the question of the Lewis guns of a company being combined in a Lewis gun platoon Of the Lewis gunners six can be relied on as riflemen; a proportion of these men are also organized and trained so as to develop to a maximum the use of the rifle grenade and hand grenade. Four platoons are banded together for tactical and administrative purposes as a company and four companies as a battalion; but for fighting purposes the platoon is the unit.

The disposition of a platoon does not necessarily insure that the men of that platoon should stand shoulder to shoulder, or even be in adjacent traverses, though they should not be scattered over too great an area. The decisive range of the modern rifle is 600 yards and a man can render very efficient aid to another by its use at 50 yards. At the same time men must be grouped in sufficient strength to give confidence and to lend support in hand-to-hand fighting. They must be sufficiently numerous to make it necessary for more than one group of the enemy to tackle one group of the defender; the German small unit is eight to twelve men, after allowing for the casualties of the latter. A convenient unit works out at the old sentry group of six men, this also suits the organization and duties the men have to perform. The plan and trace of the trenches must be so designed to enable these groups to bring mutually supporting fire, and also to support the platoons on their flanks. A good disposition is for the riflemen to be

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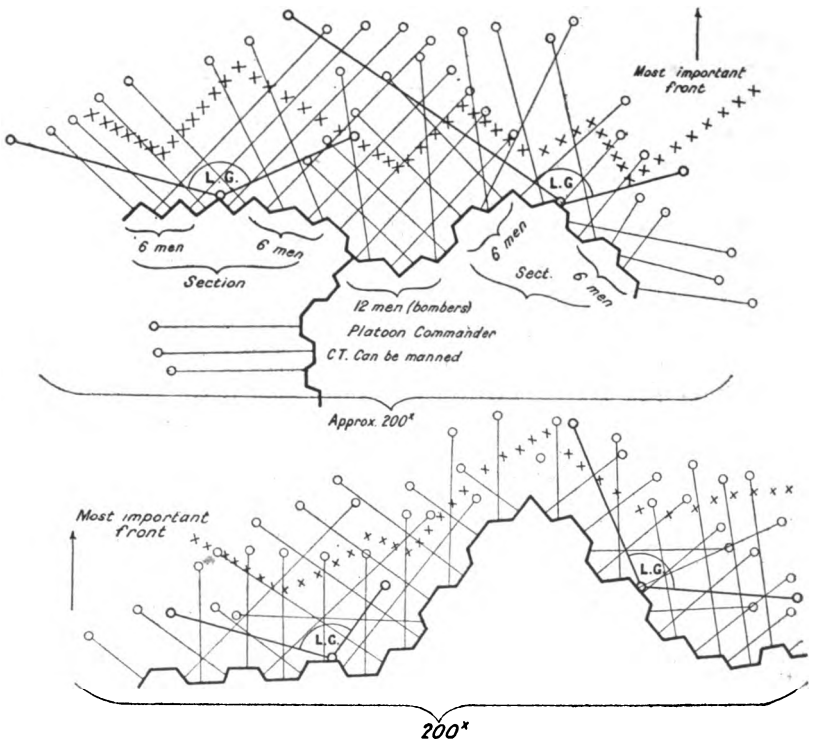
disposed to protect the Lewis guns, which protect the intervals between platoon posts, and the fronts and flanks of the neighbouring platoons. Owing to its tremendous power this weapon is particularly suitable for this purpose, but must not be absolutely relied upon, as it is delicate, liable to jam and can be easily put out of action by one hit. The rifle grenadiers and bombers can be so disposed that they may deal with parties of the enemy gaining a footing in the trenches, or attacking in a way that renders the use of these weapons desirable. In fact they can be used as the platoon commander's local reserve, using the weapons most suitable for the occasion.

In siting the above-mentioned trenches these groups of posts should be combined in localities of one or more companies with curtain troops between. Of that more anon.

All units must be disposed in depth. No disposition will enable all the fire of the unit to be brought in any direction without movement, but the trace must be such as to bring the maximum fire in the most important direction, and as large a volume of fire as possible to the flanks, taking that as the front, at once. Some traces and plans suitable for this purpose are illustrated below.

These designs, however, are only intended to be types. In each case the situation must be appreciated. The resources probable to be at disposal, the minimum number of men essential to the position, their effect on the action of the enemy and the way he would



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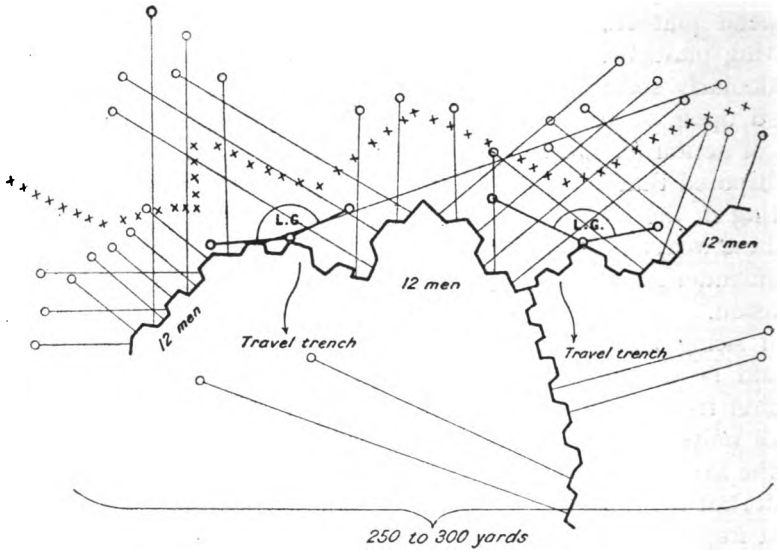
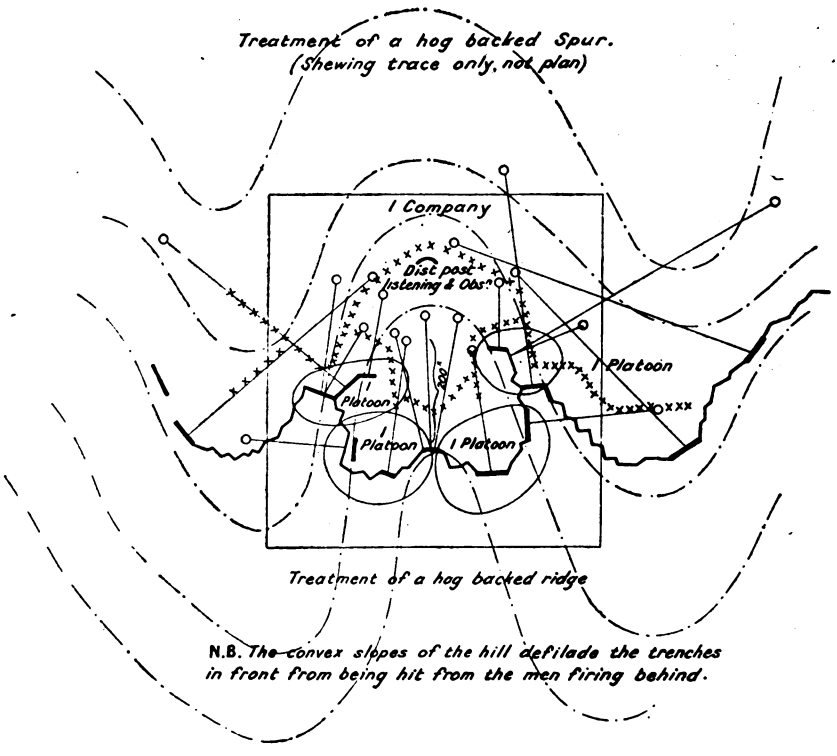


N.B. *In above the dispositions are such that any flank is readily reinforceable.*

Treatment of a hog backed Spur.
(Shewing trace only, not plan)



Treatment of a hog backed ridge

N.B. *The convex slopes of the hill defilade the trenches in front from being hit from the men firing behind.*

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set himself to unravel the problem set him, must be considered. On these must the dispositions be made and on these the siting, trace and plan of trenches decided. All probabilities must be legislated for, but to ensure success all possibilities must be provided for. Provision for meeting these can only be efficiently made by the presence of a reserve. With the limited number of troops that would be available to meet the first action of the attacker, economy in men tied to a position is absolutely essential.

The artillery of the defender will be at the first not organized to its full capacity. Hence the absolute necessity of early warning of batteries of impending enemy action. Good observation of infantry movement is important. The farther away the enemy dispositions can be gauged the more economical will be the use of the artillery, and the more efficient will be its action. Means of visual signalling must be provided for. Telephone communication will be non-existent or ill-organized and overcrowded, and difficult for strangers to find. The defender will, in the opening stages, have to rely almost implicitly on rifles and machine guns for effect.

The reorganization of the retreating forces is the great essential. On all roads leading from the front means of checking stragglers must be provided. This should not be attempted in front of the defensive line or near it. Pickets may be placed to divert organized formed bodies to essential points, but their main object should be to divert the retreating men to the main collecting stations which should be in rear, out of view of the pursuer. These stations should have means of readily blocking the roads, and must be at some open space where the men can be formed up properly, fallen in and told off into organized formations, issued with ammunition and essential equipment, of which they will be largely short, and then marched off to their pre-determined battle stations. The choosing and provision of these rallying posts is an essential part of the defence scheme and is second in order of importance to the check line. The necessity for organization of the defence cannot be too greatly emphasized, men hold a line and not a trench system, and the provision of any means that facilitate it is the most important item of any defensive system. The parade grounds for the reorganizing of the retreating force must be laid out, should be wired off and the routes thence to the localities where the troops will be required must be developed and well notice-boarded.

This brings us to the main battle position on which the brunt of the enemy attack will fall. The principles for its defence are all laid down in *F.S.R.* and the *Manuals of Military Engineering*. In a manner they conform to the principles for the outpost line as laid down above. Important localities, and localities unsuitable for manœuvre, will be held by garrisons told off for this purpose. These garrisons must be reduced to a minimum with the object in view, and defences sited, traced, and planned so as to develop

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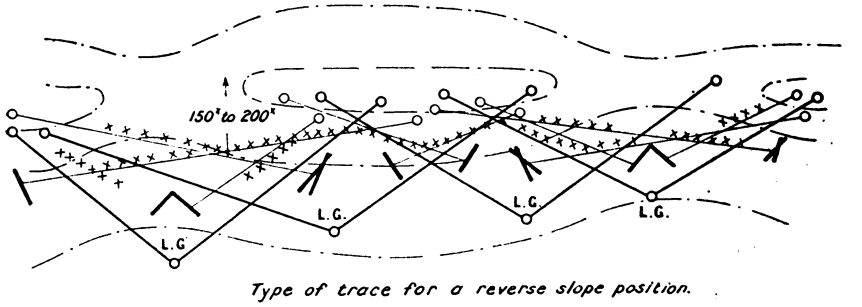
their weapons to the utmost. As many men as possible must be released as reserves to meet eventualities. By this means alone can possibilities be insured against. Special arrangements can be made to deal with probabilities, but in appreciating the situation care must be taken to avoid the fatal error of begging the question. Before coming to the main battle position the enemy will have largely shewn his hand by the way he has dealt with the outpost position. If good communications exist his ultimate action can be met by the proper use of the reserves. Generally speaking night dispositions have no bearing on the siting of the main battle position. This line must be tactically sited on the lines of the old defensive disposition, as laid down in the text books. Modifications due to altered conditions must be made. By this time the attacker will have a strong force of artillery and will be making use of gas in effective quantities. Cover from observation should be well considered and localities susceptible to gas avoided.

This brings us to the knotty question of a reverse slope position. A reverse slope position is not one that fires up-hill as is generally supposed. It is one on which the enemy cannot observe his artillery fire, unless he himself is so close as to discount its value. To obtain this means that the trenches will have a very short field of fire to the front. In order to obtain the best value of the rifle it is essential that trenches in a reverse slope position should be traced and planned to obtain enfilading fire on the narrow piece of ground on which the field of fire lies and mutually to support each other.



Type of trace for a reverse slope position.

It is important that the existence of a reverse slope position should not be emphasized to the enemy by the placing of the wire where he can see it from a distance. A space of 50 or more yards in front of the wire must be in view of the trenches, that being where the casualties occur to the attacker, not in the wire. Portions of the defence system will need special measures and stronger garrisons. They will be localities the possession of which by the enemy gives him a decided tactical advantage, or which provide a dangerous approach to the systems, or which are necessary to the defence to act as points of manœuvre. These form defended localities. A defended locality consists of a combination of mutually supporting

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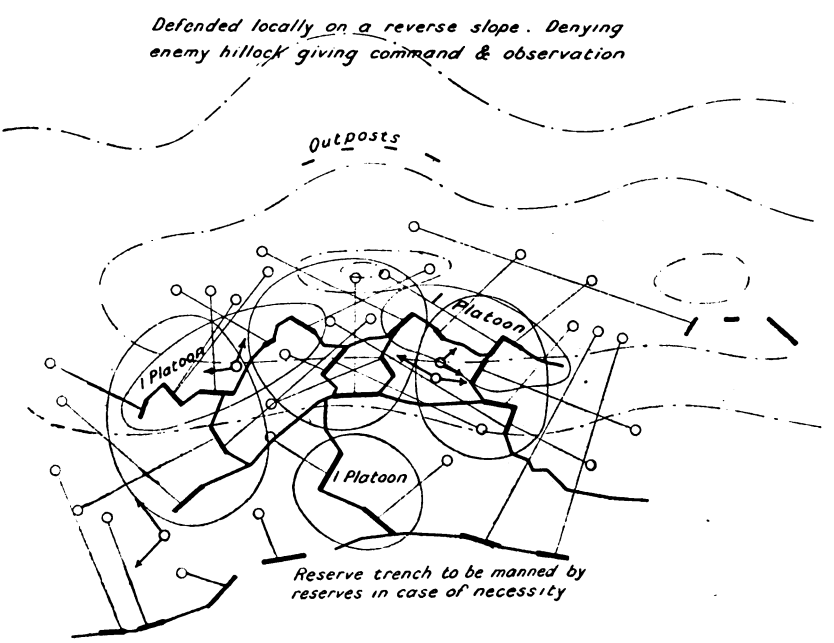
strong points. In this respect the idiosyncracy of the soldier must be taken into account. The present day soldier is not prone to stay in a position where he is in danger of being cut off. Hence we can no longer arrange for all round systems of strong points, each holding out in its own and fighting to the last. Connection must be ensured. However, falling into the opposite error of providing a complicated system of successive lines of trenches, which provide an excuse for retirement and which disperse the defence in depth, must be avoided. Any form of work which keeps a large number of men employed at decisive moments is fundamentally wrong in design. The strong points must be so designed that to obtain success in any one the enemy must operate in such numbers, and over such an area, as to bring into play its neighbours. In fact he must be compelled to attack the defended locality as a whole. The dispositions of the locality must be such that the fall of one or two of its points do not necessitate the fall of the remainder, and facilitate counter attack to regain possession of the lost points. To this end must the defences be arranged and the garrison disposed. The action of the attacker and any of his dispositions which would specially favour him must be provided for. In fact he must be given the credit of doing nothing wrong and the defence the discredit of only average intelligence. At the same time no opportunity should be lost of inveigling him into traps where he may incur serious losses and offer opportunities for a successful offensive.


Defended locally on a reverse slope. Denying enemy hillock giving command & observation
Outposts
1 Platoon
1 Platoon
1 Platoon
Reserve trench to be manned by reserves in case of necessity

The above design keeps one platoon in reserve, allows each platoon a modicum of reserves and facilitates, by the cross fire of neighbouring

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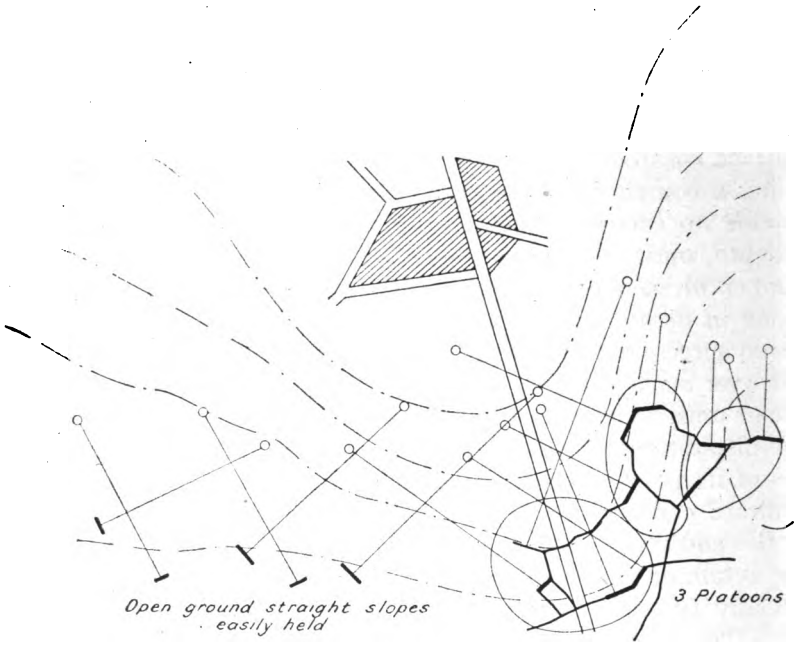
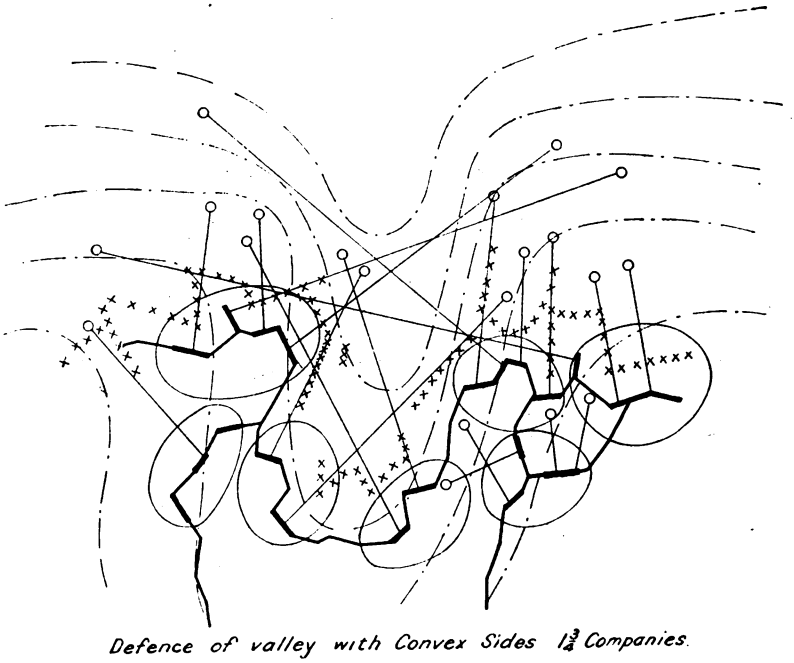


locality covering exits of a village offering approach to a convex hillock by valley. Left flank easily guarded.



Defence of valley with Convex Sides 1¾ Companies.

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posts, the recapture of any post that may fall by means of local counter attack. In case of serious pressure the reserve trench can be manned by reserves, and render support to the defence before its fall, by aid on flanks.

In the samples opposite the practice of retiring the trench on the top of a hog back ridge may be deemed to need some justification. It is contrary to the general practice. Much experience of these spurs shows that a fairly good shoot with grazing fire can be obtained longitudinally, but the convexity obviates any shoot transversely. The retiring of the flanks allows the attacker to approach a trench on the top from the flank in two directions, whereas placing trenches firing to the front down a hill-side, where the curve changes, enables a fire to be directed to one flank and the front. The uphill front is then flanked. Enemy attempting to approach from this flank are dealt with from the retired trench on the top. To proceed against this latter trench they are forced to approach on a narrow front. The defence of a hill lies in the shoulders and not the top. These dispositions also cover the flanking valley.

The diagrams overleaf show flank trenches on the reverse slope behind spurs with the main trench at the top retired behind the crest and a lightly held line in front of crest at the top. The reserve line is thrown back from this to reinforce defenders from an enemy working up the flanks. Enemy attaining the top without taking the shoulders can be held from exploiting their success, for they come under heavy artillery fire and are open to a counter attack from both flanks.

If it is necessary to hold a hill some adaptation of the above is suggested. But the main defence of a hill, which must always present a favourable target for artillery, should lie in covering its approaches from the front by the flanks. These should be secured. It must be remembered that observation is not obtained from the top of most hills. The observer has to advance some way down to obtain an effective view.

The reserve line should be what its name implies. It should be a line which can be occupied by reserves where necessary and thence reinforce the battle system, lending aid to defective flanks or weak points, and affording help to counter attack by the reserves. It is not part of a separate system. Being hurriedly occupied by troops in emergency, who have not the same time to acquaint themselves with the lie of the land and points which have special facilities for defence and offence, and also the necessity not existing so greatly here for the economy of men, since it would be occupied when a definite situation has developed, it can be simple in trace and designed to be held in long lengths. Its trace should be designed to develop fire to cover the points it is intended to reinforce in that area, and to facilitate counter attack. It should fire in the direction more directly of its front, as troops

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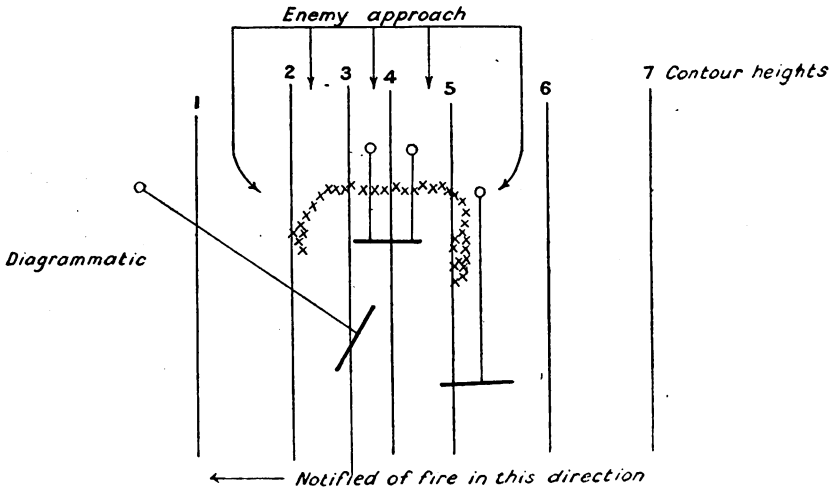

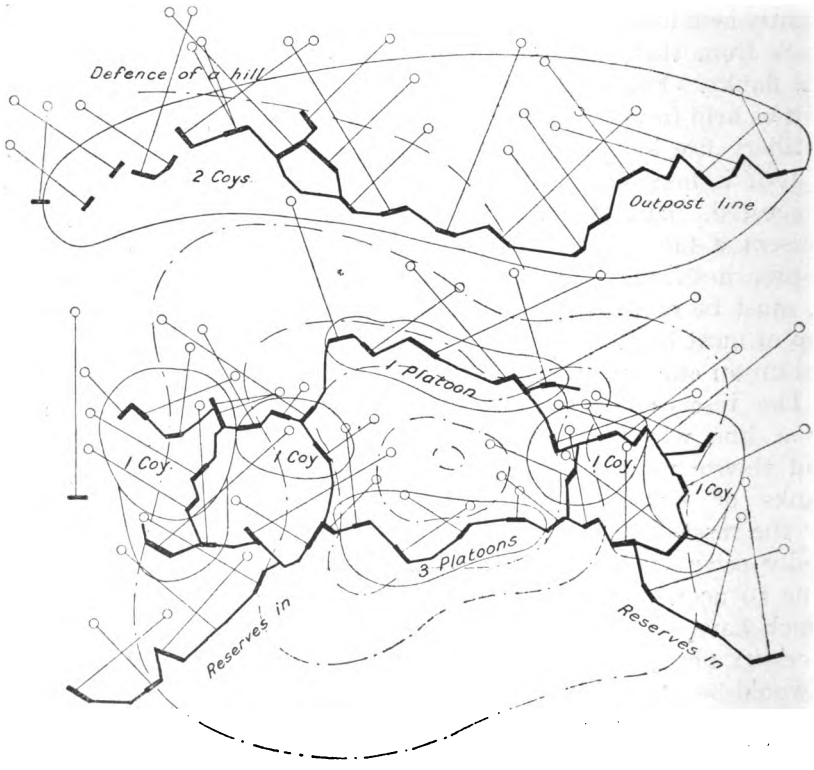

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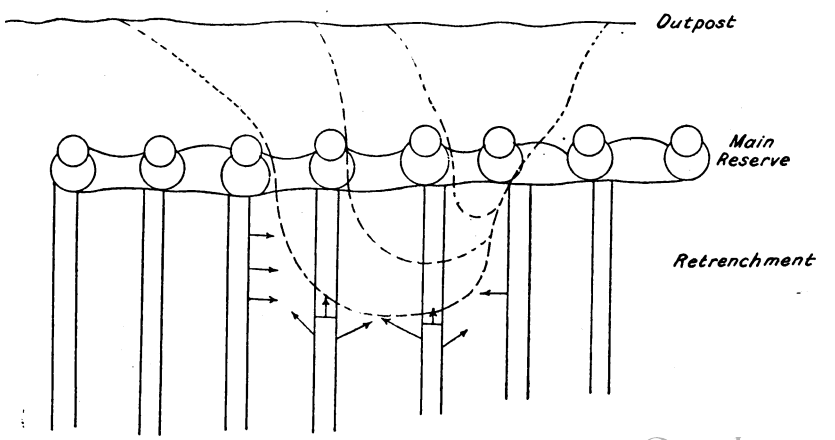
being sent to reinforce a particular part will move to that part, and not to a flank at any distance. The keynote is simplicity. Plentiful and good communication to it is an essential and probably its most important point. The way in which it can be worked into defences is shewn in the diagrams of defended localities. It must not be considered as a billet for reserve troops. These are much better kept concentrated in definite centres of communication and not spread over a line.

Like other lines it should be wired, but good and frequent gaps must be provided in those places favourable for egress for counter attack. These places should be well placarded, and it is a considerable help to the reserves and to their economical employment if the positions of these gaps is denoted along the lines of approach to the reserve line.

Having dealt with the outpost line and battle positions which consist of a main, and reserve lines, there remains the retrenchment. Though the battle must be fought on these lines, it is obvious that arrangements must be made so that the piercing of the above system at one or two points will not mean the turning of the position. It is assumed that the local reserves will have been used in trying to fight the above positions, any remnants strengthening the flanks of the gap made. The enemy would essay to develop his success by widening the gap, which must be prevented, and turning the flanks of the broken positions. The retrenchment must be designed to prevent this. It does not matter how far he advances on a narrow front, by doing that he is courting a reverse. The retrenchment works must be sited, traced, and planned to support broken lines and prevent expansion sideways. At the same time by being successful against one or more retrenchments he will be able to afford a corresponding advance. The more retired portion of the retrenchment should be designed to prevent him doing this. It must be able to fight to the front as well as to the flank.

This is illustrated in the following diagram.



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The broken lines show possibility of enemy advance according to his expansion. It is obvious he could not advance to that depth on the front he originally penetrated without running serious risks, but, in order that he may be hampered in his advance against the third line of retrenchment after having broken one, the remaining part of the broken retrenchment should be able to take him in flank. The retrenchment would then take the form of a series of localities in depth specially designed to prevent expansion from the front, but of which the rear ones would also fight to the front and form the nucleus of a new defensive line in case the reserves were not able to restore the situation. The more advanced should also serve the purpose of a gun line. These localities must also be so designed and sited that they are able to combine with their neighbours to form switches as required. In their design it must be borne in mind that they will in great probability be fought by the general reserves who may be strangers to them. They must therefore be simple in character and obvious. In this respect villages are unsuitable for them, for though villages can be made strong in these circumstances where the enemy will probably not be able to develop his artillery, village defences are always complicated and troops easily lose their way in them. Also the M.G. emplacements will be in all probability largely manned by mobile machine gunners rushed up in a hurry. Elaborate and intricate schemes should not be introduced; a large proportion of the positions should be near good routes; obstacles must be used with discrimination. It is on the cards that cavalry will come into play at the later stages, and the defending cavalry must not be hampered more than is essential. In the later stages the enemy will put in his cavalry and armoured cars. Special defensive measures for roads must therefore be made. Special attention must be made to the marking of artillery positions, and for the defence of batteries from small parties of enemy. Escorts for artillery may again be required, and their number can be minimized by devising defences which they can hold.

The artillery of the enemy will probably be limited to field guns and medium trench mortars. The defences should be planned and designed for these. His heavy artillery will only affect the forward ones in any large degree. Note the gorge defence is weak, the defender may lose a locality and wish to counter attack it The retrenchment inside is not in the nature of a keep, but a place for small local reserves, which can aid counter attack on any trench that is lost by covering fire and from whence they can counter attack.

Nothing much has been said in these notes on communication trenches. By the reduction of the numbers holding trenches the traffic in the trench will be reduced, and the number of communication trenches required falls. They should, however, not be too few or the enemy will be able to concentrate his artillery on them.

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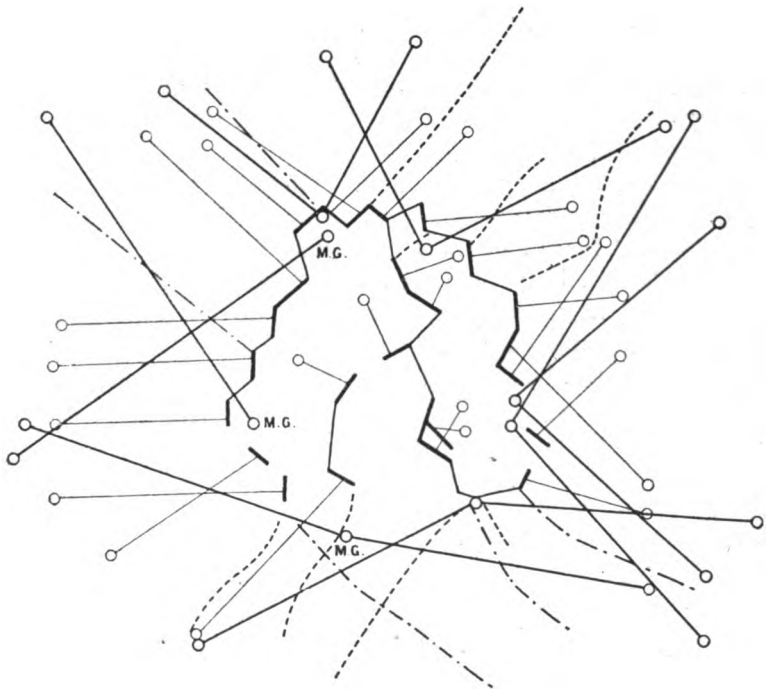
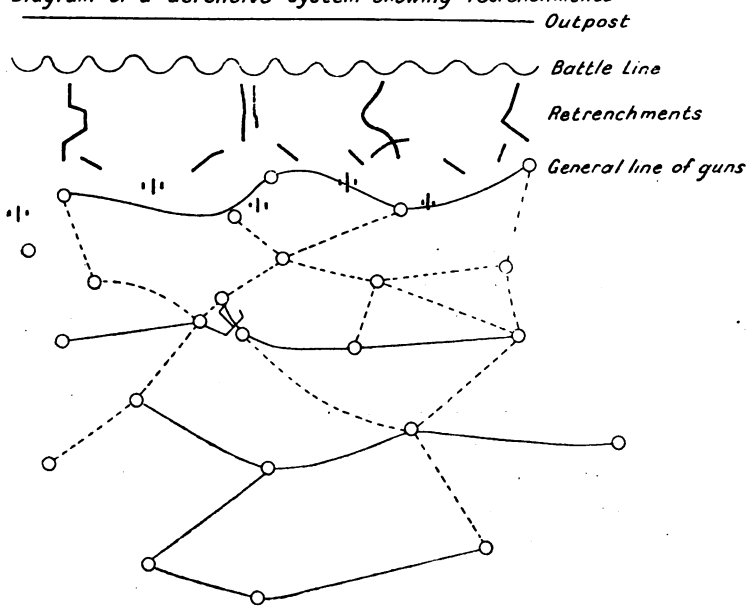
A type design of a retrenchment locality on open country



Posibilities of early alteration into a south facing alternately shewn —.—.—.—.— or ----------

Diagram of a defensive system showing retrenchments



Note the distance of these localities should not appreciably increase but their interest can become greater the further they are from the line.

Possibilities of combination in Switches ------

" " " " Line —.—.—

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Generally speaking the trenches which have been traced to lend depth to the defences can be connected into communication trenches. This is shewn in the diagrams. In practice this will work out sufficient for the frontage but additional C.T's. may be added if necessary, taking care they do not interfere with and mark the tactical trenches.

Switches are a difficult question. They are much more simple on paper than in actual practice. Defences are tied by natural features, and it is seldom these fit in with the diagonal line on the ground, added to the point that a switch which proceeds over any distance serves no useful purpose as a communication trench, as it leads from one unit area to another. Additional difficulty lies in demarcating the boundaries of limits of units along it. To put switches in also leads to a presumption of the course of action an enemy will take. He will quite probably act so as to turn it. It is not denied that they are extremely useful but it is held that, if the principles enumerated in these notes are held to, they will find their way in naturally. The term should not be abused as is the word "depth."

Large switches are dangerous things. They are easily turned. They should be used for retrenchments in obvious positions but, as stated above, they are liable to be based on a premature assumption of a course to be followed by the enemy. Probably their most effective use is to make the enemy attack localities the possession of which outflanks them. This to some extent pins him in his course of action. As such their use is strategical and outside the scope of this paper. When constructed they should conform to the general lines of a defensive system, but again, as they would in all probability be manned by strange troops, they must be simple and obvious in character, the economy in troops not being so essential as arrangements in this direction as they will be manned when the enemy has shown his course of immediate action. They will be based or run back to lines of the same construction as already mooted above, the portions of which would generally have to be occupied under the same conditions, *i.e.*, when the enemy has already accepted defeat on the lines in front.

The defence of villages is in these notes deliberately shirked. It requires much thought and a volume of its own, and each village requires expert treatment on its own.

The defence of woods is another question that will not receive much attention. The development of gas has much altered their defensive value. Where the enemy is not in a position to use gas the best line undoubtedly to take is through the centre with outposts in front. Where he can use gas it is a question of the back edge, or retiring and watching the exits. This latter course is not to be recommended as it gives the attacker the advantages of approaches

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and observation from cover. This, however, is a matter in which I have no personal experience. I know the back edge is unhealthy, as it seems to afford a very easy artillery mark. Where the attackers artillery and gas is limited, the position of the main line through the wood with an outpost line near the front edge and the reserve line on the back edge is recommended, provided a wood of the requisite size can be obtained. Woods, however, should be treated as villages, on their merits.

September, 1918.

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THE SITING OF TRENCHES.

By H.B.

TRENCH work was undertaken on a vast scale in France during 1918. Sir D. Haig's dispatch revealed the fact that 5,000 miles of trenches were dug between 21st March and 31st July, forming an entirely new network of defensive systems, many miles in depth, on the British front.

Probably three-quarters of the total was in ground where reconnaissance, tracing and digging by daylight were possible; but the conditions imposed by the German offensive necessitated the work being carried out at high pressure and with the utmost speed during the first two months; a great deal of the *detailed* siting of trenches, therefore, had to be left to inexperienced officers, hastily gathered from all sorts of units and organizations.

The results, as might be expected, were by no means perfect, for zeal and hard work cannot replace knowledge and experience; and no pamphlet on the siting of trenches was in existence. Information on the subject is included, of course, in many official publications, but it is not in a form adapted for use under these conditions, and from a practical point of view, therefore, was useless.

Such a pamphlet must be logical in its sequence of thought, concise and dogmatic. General statements are of no value to the inexperienced man; they merely add to the confusion in his mind; even at the risk of error, dogmatism is a necessity.

The following notes attempted to meet this want; they represent the joint efforts of several officers, and were issued almost in their present form. It must be remembered that they were intended to meet the conditions obtaining on the Western front and that these conditions included (*a*) continuous lines, (*b*) masses of artillery and trench mortars of all calibres, (*c*) gas shelling on a big and ever increasing scale, (*d*) heavy morning mists.

A diagram and two small plans of actual trenches are appended to illustrate the notes, which (it is believed) are strictly based on the teaching inculcated in various official pamphlets.

SITING A DEFENSIVE LINE.

Preliminary Note.—A properly organized defensive system consists of three zones:—(i.) the out-post zone, (ii.) the main battle position, (iii.) defended localities and areas in rear of the main battle position

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in which reserves can be accommodated, and which are capable of being held as a battle position in case of necessity.

The object of the outpost zone is to secure the main battle position from bombardment by the enemy's trench mortars, to prevent the mass of the enemy's artillery concentrating on it and the defensive positions in rear, and to split up the enemy's infantry attack before it reaches the main defensive position. It usually consists of sentry groups, a picquet line and support line; but the trenches forming it are not necessarily continuous, nor so organized as in the main defensive position. The barrage of the defending artillery will fall as a rule behind the sentry line and in front of the *outpost* line of resistance. The depth of the outpost zone will be anything up to 4,000 yards, or even more in special cases. On the battle front the position of this zone has been decided by fighting.

The main battle position is constituted in much the same manner, but it is more highly organized in every way. The question of siting the main infantry line of resistance in the battle zone will now be discussed.

Main Infantry Line of Resistance. Battle Zone.

1. The general line is decided by considerations, such as the defence of a port, line of railway, some area of country, certain towns, or the like, which determine the approximate distance at which the line must run to protect adequately the piece of country in question. This general line can be drawn on an uncontoured map, 1/100,000.

2. This being settled, the next step is to take the layered 1/100,000 map and site on it the main infantry line of resistance which fulfils the requirements of the general line, according to the features of the country. The approximate line can be marked on it very quickly, as the layers show heights, ridges, spurs, etc., which must fall within our line.

3. In selecting this approximate line of main resistance the following principles should be followed:—Artillery observation of the ground, for at least 400 yards in front of the line of resistance, is essential. Where this can be obtained from higher ground in rear, or from flank positions near, advantage should be taken of reverse slopes in siting the infantry position, so that, while the enemy is under observation, our troops are concealed from his view. When such observation is not possible, the line of resistance should be on the forward slope and sufficiently far down it to cover artillery observation from the crest.

Important tactical features should be decided on first, and treated as localities or groups of trenches; the lines connecting them are altogether subservient and must be fitted in as best they may. Any attempt to make a continuous line strong everywhere will probably lead to it being a compromise and ineffective.

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In dealing with woods the line must be taken either outside them, well inside, or behind them; they harbour gas and it is always difficult for the enemy to emerge from them, particularly if the edge is entangled.

Villages afford concealed approaches and a certain amount of cover in cellars; but as they are always heavily shelled, the line should run well in front of them as a rule.

4. The R.A. and M.G. officers concerned in the reconnaissance should now visit the ground, taking a copy of the layered map, with the approximate main line of resistance, marked on it.

The R.A. officer marks on a 1/40,000 map the positions necessary for O.Ps. to control artillery fire; and the M.G. officer marks M.G. positions for defence of the line in depth on a similar map.

If the line is likely to be attacked in the first instance by enemy having nothing but the usual proportion of field artillery and with little or no heavy artillery, the advanced M.G. positions may be pushed well forward in the defensive system, so as to engage the enemy with direct fire as soon as possible; but M.G. defence in depth is always essential.

The necessary information to get out the final siting of the trenches on the ground is now available.

It will save much time if a few flags are put out in prominent positions along the line before the R.A. and M.G. officers go out, as this helps identification. If the line is a long one, it should be divided into sectors of not more than 6 miles and the officers in charge of the sectors, sent out to study the ground, the enemy's lines of attack, and the best way of dealing with them. To do this it is necessary to examine the ground from the enemy's point of view.

5. The main infantry line of resistance can now be sited in detail. Generally speaking, it must not run behind any R.A.O.P., and certainly never behind any important one.

If artillery observation (*vide* para. 3) can be obtained from heights in rear, the line of main infantry resistance should be on a reverse slope with local observation pushed forward over the crest.

If artillery observation can be obtained only from the most forward ridge inside our position, then the line of main infantry resistance should be pushed forward several hundred yards to cover it. The proper construction of C.Ts. enables such forward positions to be strongly manned at short notice by troops held under cover in rear.

If the line at any point is commanded badly from the enemy's side within a range of 5,000 yards, our line should run not nearer than 1,000 yards to, and not more than 2,000 yards from, the commanding ground. If nearer than 1,000 yards, the trenches will be badly sniped, and if within 2,000 to 4,000 yards the trenches can be

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plastered by shrapnel to which very little reply can be made. This is a good working rule except in close intersected country, but must be used with common sense.

6. The line selected should be marked out on the ground by flags or stakes. After this line has been adjusted, a furrow should be cut with a plough to show its approximate position.

The line can then be divided among officers for the siting of the individual trenches. This can be done by using lengths of tape with pegs at each end. Normal widths of traverse can be left by eye or paced; the great point is to site the fire trenches, remembering that a man normally fires on a line at right angles to the parapet. The traverse can be put in subsequently, provided that enough space is left.

7. Trenches should be sited in general conformation to the contours so as to give mutual enfilade fire. This ensures converging fire being brought to bear on valleys, which are the most likely avenues of attack and penetration.

Enfilade fire is most demoralizing to an attacker and also most heartening to the defender, for he is shooting at men who are not attacking him and probably does not see the men advancing on his own particular trench, who will be dealt with by other trenches on the flanks. Great care must be taken, therefore, to ensure that plenty of flanking fire is provided, both by large waves in the general line and short flanks in the trenches. If any portion of the front is penetrated, enfilade fire from the flanks will prevent the enemy reinforcing or exploiting the penetration.

The general alignment of trenches will, therefore, be very irregular, following the lie of the ground, forming alternate bastions and curtains, running forward on spurs and back in the valleys. In addition to increasing the fighting strength of the system, this course adds very considerably to the difficulties of the enemy artillery barraging it.

8. Communication trenches should be numerous, capable of being fought, wired and arranged, as far as possible, as switches.

Apart from the confidence with which C.Ts. inspire forward detachments, their value, on account of the possibilities of defence which they afford, is not always sufficiently realized and exploited. They should always be sited with this in view, in combination with the fire trenches, and not left to anyone to lay out in conventional zig-zags or waves. Thus dealt with they may convert a few scattered trenches into useful tactical points.

9. Drains for all trenches must be considered and marked out when the trenches are sited in detail. They should be dug simultaneously with the trenches they serve and should always be completed to the full width and depth, even when the trenches are left to be deepened subsequently.

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10. Machine guns should have several alternative positions, sited to suit the different phases of the fight. In the first instance, some should be well forward, so as to engage the enemy at long range but in addition, they should have concealed positions distributed in depth from which they can flank neighbouring defences and bring fire to bear on all main avenues of approach. They are always fought in pairs or in groups of 4 guns (*vide* para. 4).

11. *Dug-outs.*—In order of importance :—

(*a*) Brigade and Battalion H.Q.

(*b*) M.G. and selected O.Ps.

(*c*) Accommodation.

In the first instance shafts only need be sunk for (*a*) and (*b*), and it will rarely be possible to do anything for (*c*) beyond improving existing caves and catacombs.

12. *Localities.*—Positions which lend themselves for stubborn defence should be developed *in and behind* the line of main resistance. Such localities should have strong all round defences. They should be mutually supporting. The flanks should be protected by defensive lines or other localities in rear as well as on the flanks. A locality in rear should be provided with :—

(1). Wire.

(2). Protection of garrison.

(3). Organization : including water, rations, ammunition and tools.

(4). Buried cables.

Concealment from direct observation is most desirable.

13. *Buried Cables.*—No defensive zone can be regarded as complete without a proper system of buried cable communications. Cables should be buried to a depth of six feet.

The provision of one buried route 4,000 yards in length to each Divisional front of 4,000 yards, should be aimed at, each bury containing 20 pairs.

14. To sum up, a defensive system will consist of :—

(i.) An outpost zone consisting of sentry posts, picket posts, etc., eventually developed into an outpost system ; the trenches forming the system need not be continuous, although the occupied fire trenches may be connected by shallow lengths, to facilitate supervision, command and concealment. In the same way the C.Ts. will be dug to full depth where absolutely essential, and in other places will be shallow with the same object in view. This zone will be fought as long as possible, but is not manned normally in any great strength. Under present conditions its depth would be 1,000—4,000 yards, or even more, depending upon the nature of the country.

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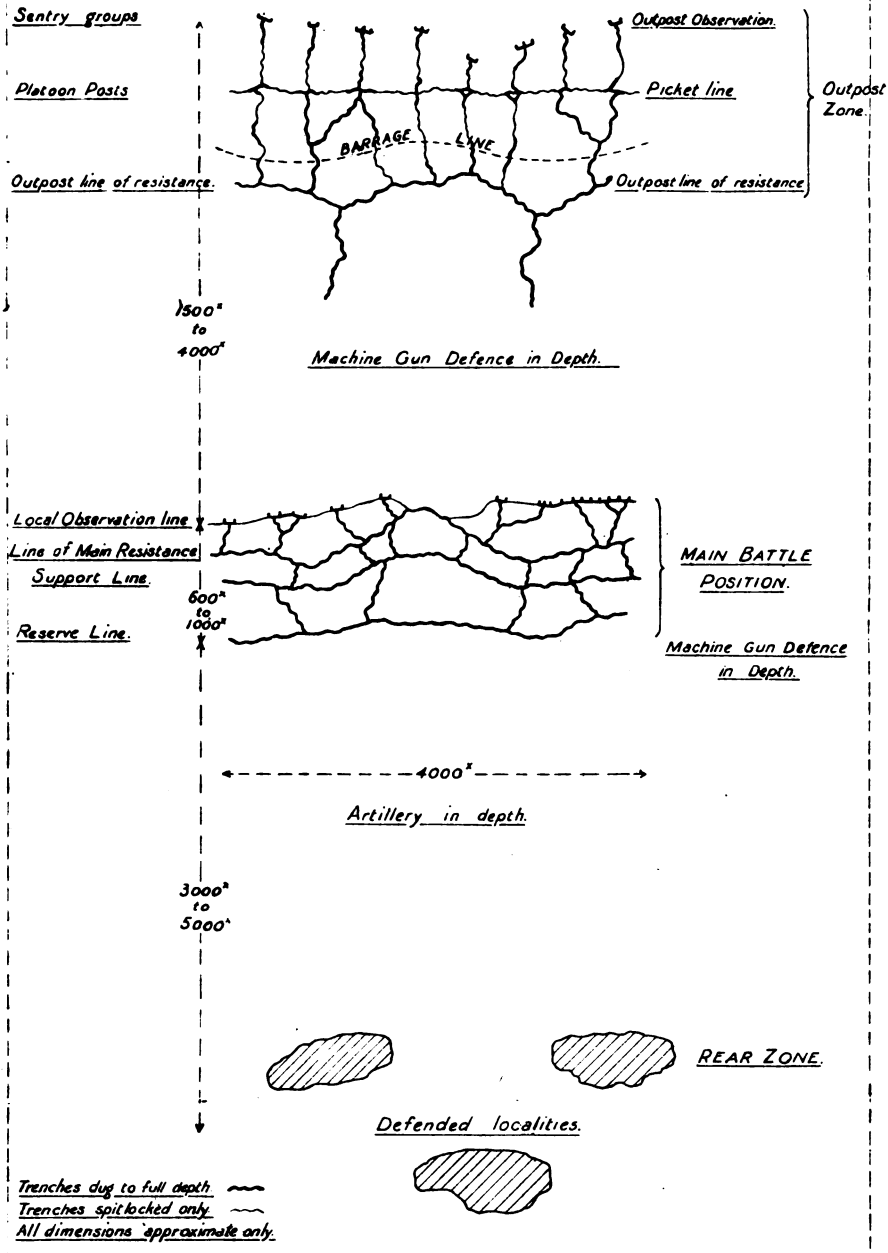
DIAGRAM TO ILLUSTRATE A DIVISIONAL SECTOR OF A DEFENSIVE SYSTEM.



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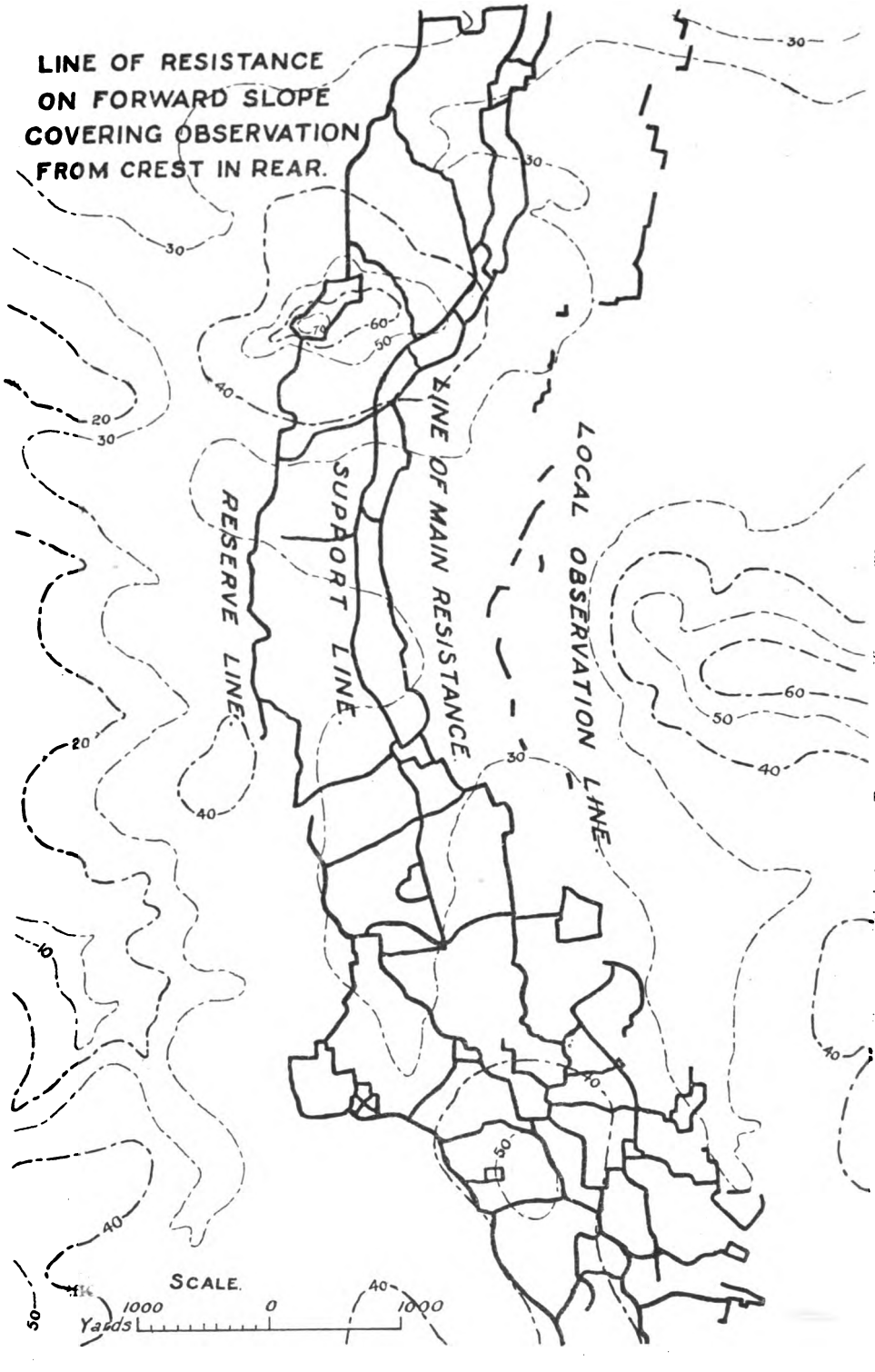

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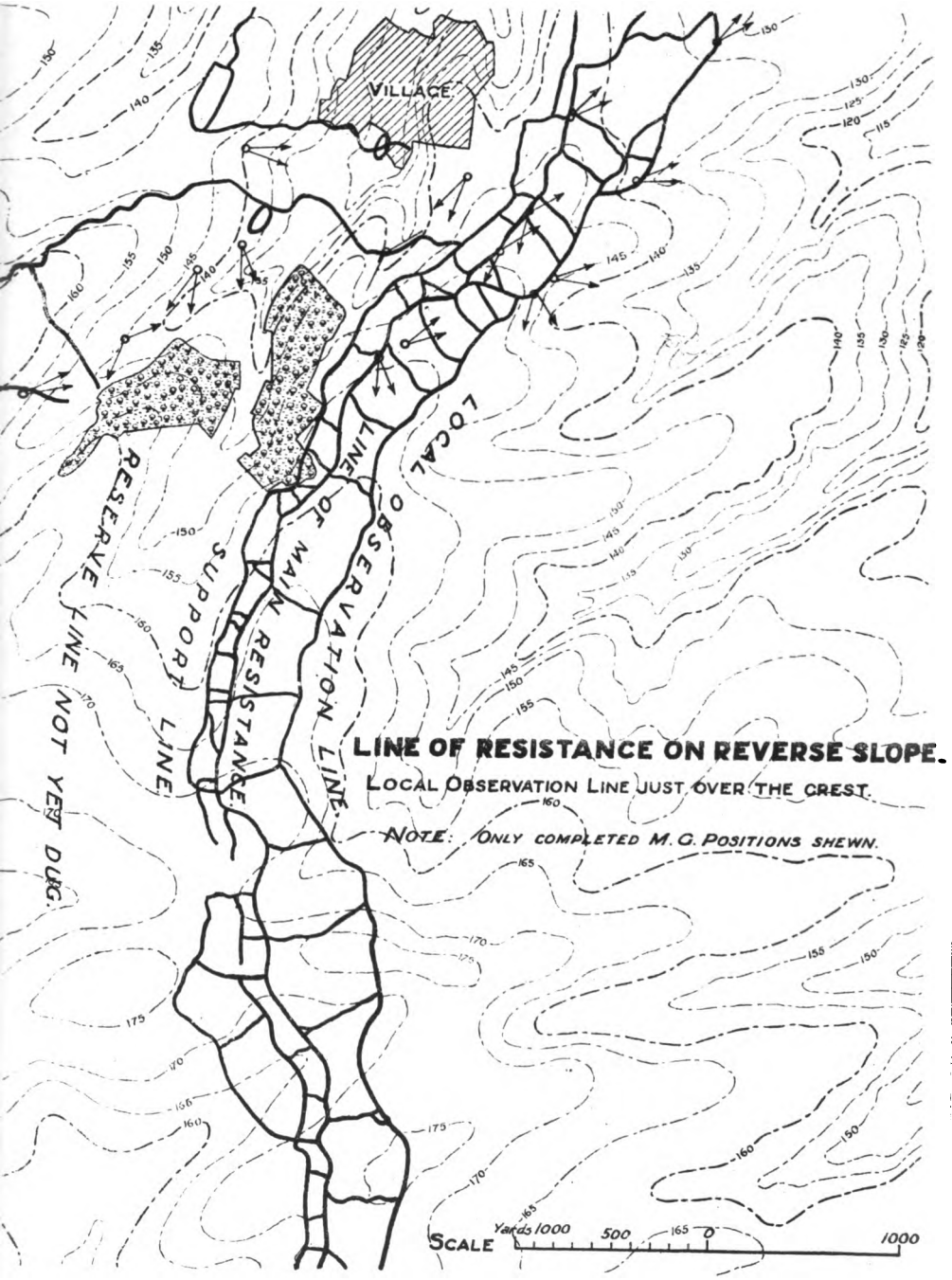
VILLAGE
LOCAL OBSERVATION LINE
MAIN RESISTANCE LINE
SUPPORT LINE
RESERVE LINE NOT YET DUG.
LINE OF RESISTANCE ON REVERSE SLOPE.
LOCAL OBSERVATION LINE JUST OVER THE CREST.
NOTE. ONLY COMPLETED M.G. POSITIONS SHEWN.
SCALE Yards 1000 500 165 0 1000

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(ii.) Main battle zone, consisting of tactical localities, areas, etc., connected together by trenches, which will be somewhat as follows :—

(*a*). Main line trench (line of main infantry resistance) with a local observation line in front of it. This observation line need not be dug throughout to full depth.

(*b*). Support trench, some 200 yards in rear of the line of resistance.

(*c*). Reserve trench, about 500 yards in rear of the support trench, from which counter attacks will be launched, in case of the enemy penetrating the main line of resistance at any point. This trench should be well hidden.

(iii.) Defended areas and localities in rear of the main battle zone, in which reserves can be accommodated, and capable of being held as a fighting position should the battle zone or a large part of it be lost.

15. Should it be decided to extend the defensive system in depth, a new position will be constructed on the same principles on a line *not* in advance of the defended localities mentioned above, paragraph 14 (iii.), and far enough back to compel the enemy to move his guns forward to attack it. Switches may connect the two systems.

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WOOD AND SHEET-IRON GIRDERS.

IN 1917 some experiments were made by Capt. Stern, R.E., and Lieut. Allen, R.E., to ascertain the strength of girders made of wood booms and uprights and sheet iron webs nailed on either side. These experiments showed that such a girder was very strong, the various parts very portable and easily and quickly constructed at site.

Shortly after arriving at this conclusion, orders were given to construct a Bridge over the river Struma at Komarian. Capt. Ferranti, R.E., was in charge of the work and carried out further experiments and tests as a result of which it was decided to place the Pile Piers 18 in. apart in the clear and use four wood and iron girders to carry a 10-ton load concentrated at the centre (factor of safety 4). Each girder to be 20 ft. long over all, 26 in. deep (the width of the sheet iron), top and bottom booms 6 in. × 6 in. timber, uprights 6 in. × 3 in., sheet iron webs 20-gauge nailed on with 2½ in. nails, one per inch.

The number and pattern for placing the nails is shown on the drawings attached and requires to be carefully adhered to. Also particular care must be taken that the sheet iron is nailed on quite flat without any bulges or blisters which would prevent the whole sheet being in tension.

Boxes of ammunition were used to weight the sheet iron while being nailed. Provided these points are attended to in nailing, the girder is extremely easily and rapidly constructed by two carpenters.

It appears to be a most suitable type for rapid construction in the Field.

Capt. Ferranti has gone most thoroughly into the calculations and records of tests. I attach a very full and thorough report which he has made. The records which he gives of the practical tests carried out are very valuable and show what an excellent type of girder it is. Each pair of girders was braced together with diagonals at each third of their length.

H. L. PRITCHARD, *Brig.-General,*
Chief Engineer, 16th Corps.

2. 12. 18.

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REPORT BY CAPT. V. ZIANI DE FERRANTI.

Various sizes of girders, having booms and verticals of wood, and web of sheet iron, have been constructed and tested. These girders had square ends with a half panel overlap beyond the points of support. The end verticals were let into the booms, the remainder skew-nailed. The web, which was painted inside and out, was fastened to the booms with nails.

No. 1 Girder, to Carry a Load of 5 Tons Distributed over 1 Panel.

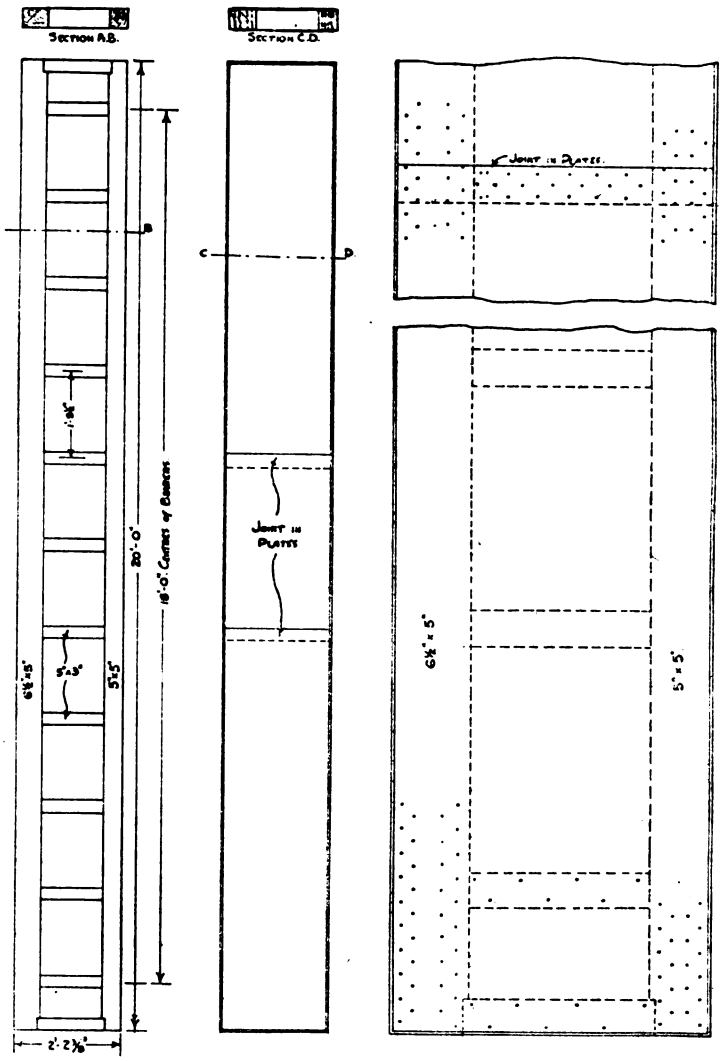

Fig. 1.—*No. 1 Girder. Detail of Girder.*

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Overall length	20′ 0″
Span	18′ 0″
Overall depth	2′ 2″
Effective depth	1′ 8″
Size of booms (top) ...	$6\frac{1}{2}$″ × 5″
,, ,, ,, (bottom) ...	5″ × 5″
,, ,, verticals	5″ × 3″
Distance between verticals	
c to *c*	1′ $9\frac{1}{2}$″ (1·8′) in the clear =18·5″.
Web...	No. 18 gauge iron (·048″)
Attachment	$2\frac{1}{2}$″ wire nails. 1 per inch.
Weight	5 cwt.

Booms.—Top.—As the bridge for which these girders were made was designed with the roadway directly on the top booms, these booms had to take the compressive stress due (1) to the load on the girder; and the stresses due to (2) local bending between panel points. As the unsupported length was so small, compared with the size of the boom (3 : 1) the compressive stresses in the top half of the boom were added. The position in which the load produces the greater stress in the top boom, is over the panel adajcent to the centre vertical.

The bending moment is at a maximum where

$$x=\frac{cb}{l}+a-\frac{c}{2}$$

$$=\frac{18\cdot6\times97\cdot2}{216}+118\cdot8-9\cdot3$$

$$=117\cdot87''.$$

The bending moment at any point x

$$Mx=\frac{Wbx}{l}-\frac{w}{2}\left(x-a+\frac{c}{2}\right)^2.$$

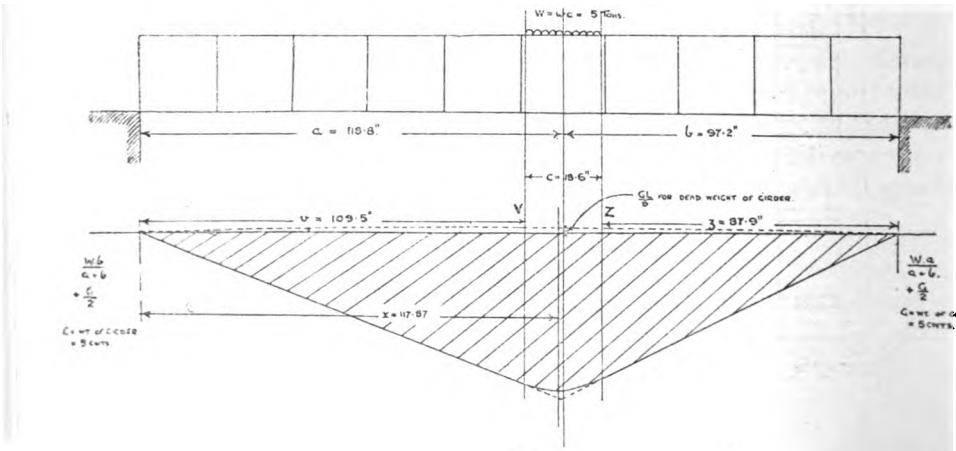

FIG. 2.

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The first term is represented by the left hand straight line (in bending moment diagram) and the second by the distance between the curve and the straight line, and the value Mx by the vertical ordinate of the shaded diagram.

$$\therefore \quad M_{max.}=\frac{5\times 97\cdot 2\times 117\cdot 87}{216}-\frac{5}{2\times 18\cdot 6}(117\cdot 87-118\cdot 8+9\cdot 3)^2$$

$$M_{max.}=255\cdot 8 \text{ inch tons.}$$

To this must be added B.M. due to weight of girder

$$\text{Approx.}=\frac{GL}{8}=\frac{\cdot 25\times 216}{8}=6\cdot 75 \text{ inch tons.}$$

$\therefore$ Total moment$=262\cdot 5$ inch tons.

Bending moment=moment of resistance.

$$262\cdot 55=f.a.d.$$

Where f=stress in tons per square inch.
a=area of cross section of boom.
d=effective depth of girder.

$$\therefore \quad f=\frac{262\cdot 5}{6\cdot 5\times 5\times 20}$$

$f=\cdot 403$ tons per square inch .....[1.]

Local Bending.—The load is distributed by the decking over the panel. The ends of the beam (viz.—over the two panel points) may be considered to be built in at a slope and at different levels (the load on the whole girder not being central).

To find the maximum bending moment these slopes and levels must be known.

To find these, the EI of the whole girder must be known (E=modulus of elasticity and I=moment of inertia of the section).

This can be calculated as the deflection for a known load was found by experiment (see *Fig.* 3, p. 330).

Let Yc=deflection at centre of girder$=\cdot 175''$
L=span $=216''$
W=load over centre $=5$ tons.

Then $$Yc=\frac{WL^3}{48EI}$$

$$\therefore \quad EI=\frac{5\times 216^3}{\cdot 175\times 48}.$$

$$\therefore \quad EI=6\times 10^6 \text{ for the whole girder.}$$

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Slopes Over Panel Points.—Let V and Z be the two ends of the panel where it is required to know the slope.

Let i_v=slope at V.

i_z=slope at Z.

Then
$$i_v = -\frac{Wb}{EI\,(a+b)}\left(\frac{v^2}{2} - \frac{a^2}{6} - \frac{ab}{3}\right)$$

$$i_v = \cdot 000{,}077$$

and
$$i_z = \frac{Wa}{EI\,(a+b)}\left(\frac{z^2}{2} - \frac{b^2}{6} - \frac{ab}{3}\right)$$

$$i_z = -\cdot 000{,}715.$$

Levels of Panel Points.—Let Y_v=deflection at V.

Y_z=deflection at Z.

Then the difference in level between V and Z will be $Y_v - Y_z$.

$$Y_v = \frac{Wbv}{EI\,(a+b)} \times \frac{a^2+2ab-v^2}{6}$$

and
$$Y_z = \frac{Waz}{EI\,(a+b)} \times \frac{b^2+2ab-z^2}{6}$$

$\therefore$
$$Y_v - Y_z = \cdot 00598.$$

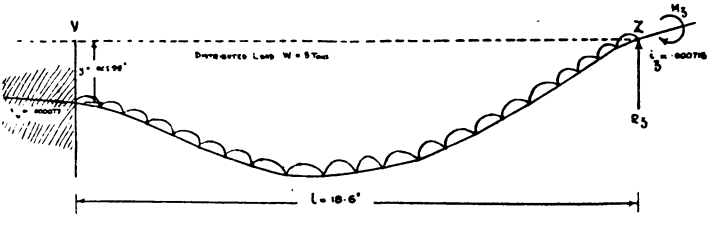

FIG. 6.

Consider the beam as a cantilever fixed at V at a slope i_v, the otherwise free end Z being propped to a height y above V and subject to a couple M_z.

Slopes.—Then the algebraic sum of the slopes produced at Z by the reaction at Z (R_z); the couple at Z(M_z); the load W and the slope at V (i_v) will be equal to the resultant slope at Z (i_z).

$\therefore$
$$\frac{R_z l^2}{2EI} + \frac{M_z l}{EI} + \frac{Wl^2}{6EI} + i_v = i_z \text{ ((a) (c) and (e) of appendix).}$$

$\therefore$
$$\tfrac{1}{2}R_z l^2 + M_z l + \tfrac{1}{6}Wl^2 = (i_z - i_v)\,EI \quad \ldots\ldots\ldots\ldots\ldots\ldots [3].$$

Deflections.—Also, the algebraic sum of the deflections produced

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at Z by the reaction at Z (R_z) ; the couple at Z (M_z) ; the load W ; and the slope at V will be equal to the resultant deflection at Z (y).

$$\therefore \quad \frac{R_z l^3}{3EI}+\frac{M_z l^2}{2EI}+\frac{Wl^3}{8EI}+li_v=Y \text{ (} (b) \text{ } (d) \text{ and } (f) \text{ of appendix).}$$

$$\therefore \quad \tfrac{1}{3}R_z l^3+\tfrac{1}{2}M_z l^2+\tfrac{1}{8}Wl^3=(Y-li_x)\,EI \text{ .....[4].}$$

Where $Y=-\cdot00598$
$i_v=\cdot000077$
$i_z=-\cdot000715.$

Multiplying [3] by $\frac{2}{3}l$ and subtracting from [4]

$$M_z=\frac{Wl}{12}-\frac{6EI}{l^2}(Y-\tfrac{1}{3}li_v-\tfrac{2}{3}li_z) \text{ ....[5].}$$

E was found by experiment to be 600

$$I=\frac{bd^3}{12}=\frac{5\times6\cdot5^3}{12}.$$

Bending Moment at Z.—

$$\therefore \quad M_z=7\cdot75-2\cdot89$$

$$M_z=4\cdot86.$$

Similarly $R_z=-2\cdot506$ tons

and $R_v=-W-R_z$

$$=-5+2\cdot506$$

$R_v=-2\cdot494$ tons.

and $M_v=M_z+$moment of whole load round $V-R_z l$.

$$=4\cdot86+\frac{5\times18\cdot6}{2}-2\cdot506\times18\cdot6$$

$M_v=4\cdot86.$

Bending Moment at V.—From the bending moment diagram it will be seen that the $M_{max.}$ occurs at the centre and is $-6\cdot82$ inch tons.

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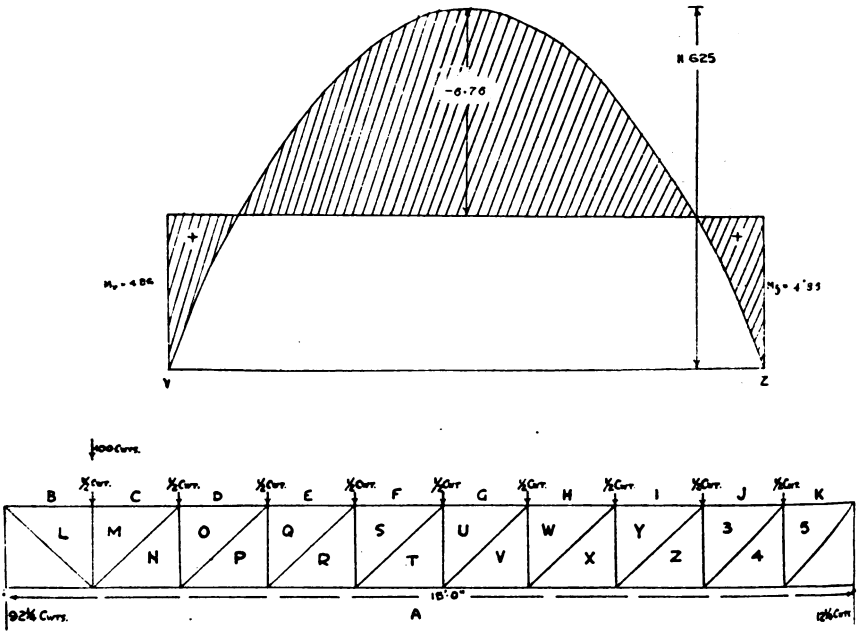
Bending Moment in Centre,—Bending moment diagram for beam loaded as in *Fig.* 6, page 326.



Scale—2 feet to ½ inch.

To find the stress produced in the top boom by this bending moment—

$$p=\frac{My}{I}.$$

Where p = extreme stress at edge of beam.
y = distance of edge from neutral axis.
I = moment of inertia of section.

$$=\frac{bd^3}{12}.$$

$$\therefore \quad p=\frac{6\cdot76\times\frac{d}{2}\times12}{b\frac{d^3}{4}\times\frac{1}{2}}$$

$$=\cdot193 \text{ tons per square inch} \quad \ldots\ldots\ldots\ldots\ldots\ldots[2].$$

Adding [1] and [2]—

Total stress in top boom = ·592 tons per square inch.

Taking the breaking stress as 6,000 lbs. per square inch (2·68 tons), this gives a factor of safety for a dead load of 4·5.

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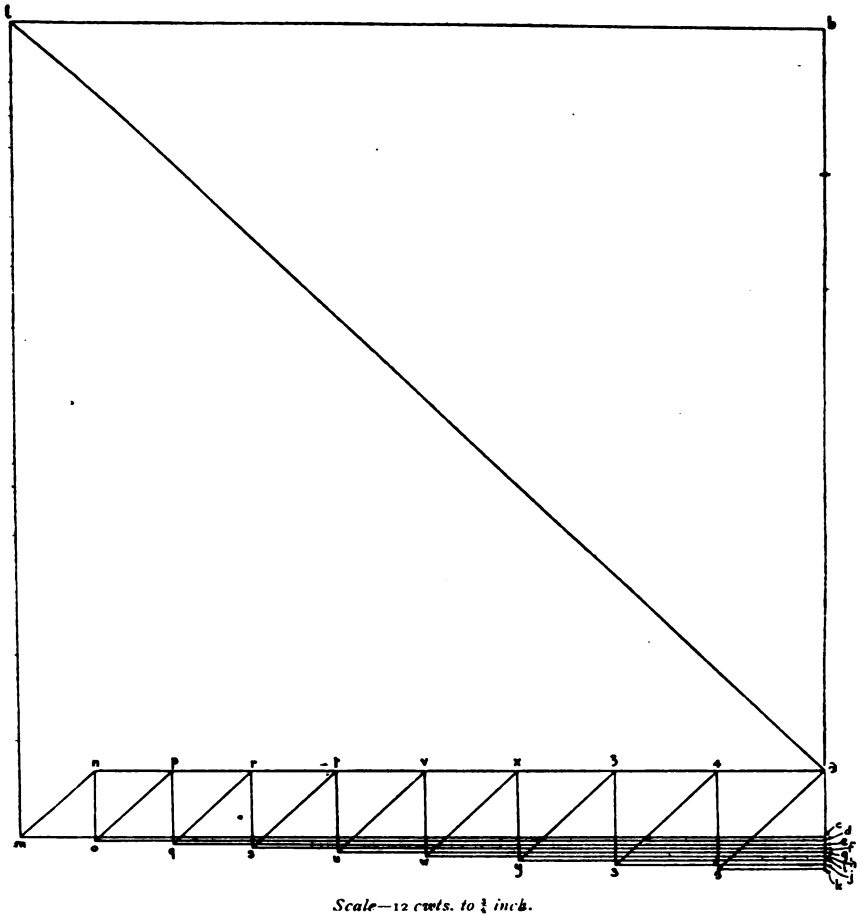

Scale—12 cwts. to ¾ inch.

Stress Diagram for No. 1 Girder.

Bottom Boom.—Worst case when load over centre.

$$6{\cdot}75+\frac{WL}{4}=f.a.d \text{ (6·75 due to girders own weight).}$$

$$\therefore \quad f=\frac{6{\cdot}75+270}{5\times5\times20}=\cdot553 \text{ tons per square inch,}$$

giving a factor of safety of 5·3.

Web.—The maximum stress in the web with a heavy rolling load is when it is over the first panel point.

This gives a load of 6·79 tons in a piece of webbing of cross-section $2\times\cdot048\times15$.

$$\text{Stress per square inch}=\frac{6{\cdot}79}{2\times\cdot048\times15}=4{\cdot}71 \text{ tons per square inch.}$$

(Breaking stress=20·5 tons per square inch. ∴ Factor of safety=4·35).

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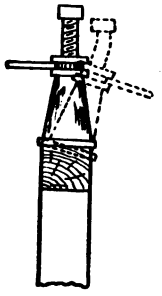
Attachment.—This was made the same strength as the iron, which (see experiments) required one 2½-in. nail per inch run.

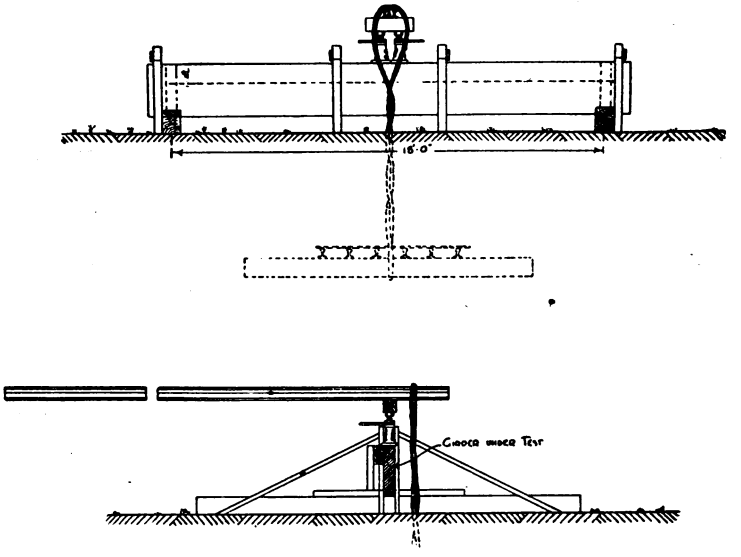
Construction.—One carpenter could complete all the woodwork in 7 hours. One sapper could nail on the web in 7 hours. One private could punch holes in one set of plates in 5 hours.

Infantry at first were employed nailing on the web but this had to be discontinued as considerable skill and care were required to prevent the plate buckling.



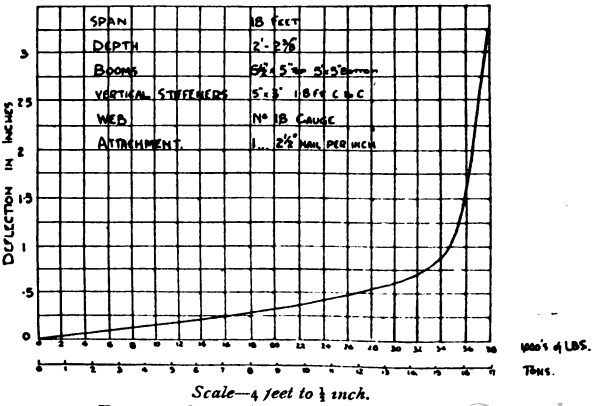
Tests.—*Fig.* 2.—The girder was arranged as shown in *Fig.* 2, and subjected to increasing loads up to 17 tons. Deflections were taken and a curve plotted (*Fig.* 3). When this load was removed the girder had a permanent set of ·3 in.

At this load the jacks bent, damaging the top boom locally.



Scale—4 feet to ½ inch.

FIG. 2.—*No.* 1 *Girder. Test of Girder.*



Scale—4 feet to ½ inch.

FIG. 3.—*No.* 1 *Girder. Test of Girder.*

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No. 2 GIRDER.—This girder was similar to the first, but had hard wood booms 6 in. × 6 in. and was 2 ft. 4 in. deep over all.

It was loaded over the central panel point and showed no sign of fatigue, though left for 24 hours with 20 tons on it. It was afterwards placed in the bridge.

No. 3 GIRDER.—This girder was much lighter than the two preceding ones. The only differences apart from this being that the web was fastened with 1½-in. clout nails which were found to be better than wire nails in very thin iron.

It was designed so that the web should fail first.

To Carry 1 Ton Dead Concentrated Load.

Overall length	20′
Span	18′
Overall depth	26″
Effective depth	22″
Booms, top	5″ × 4″
,, bottom	3″ × 4″
Verticals	3″ × 4″
,, *c* to *c*	
Web	No. 37 gauge iron (·0068 in. thick).
Attachment	1½″ clout nails 1 nail per in.
Weight	1⅔ cwt.

Booms.—Top.—

$$\frac{WL}{4} = f.a.d.$$

$$\therefore \quad f = \frac{1 \cdot 18 \cdot 12}{4 \cdot 20 \cdot 22} = \cdot 123 \text{ tons per square inch.}$$

Local concentrated load with ends built in

$$M = \frac{WL}{6} \qquad y = \frac{d}{2} \qquad I = \frac{bd^3}{12}$$

$$P = \frac{My}{I} = \frac{WL}{td^2}$$

$$\therefore \quad P = \frac{1 \times 20}{4 \times 5 \times 5} = \cdot 2 \text{ tons.}$$

∴ Total stress in top boom = ·323 tons per square inch.

Bottom.—

$$\frac{WL}{4} = f.a.d.$$

$$\therefore \quad f = \frac{1 \cdot 18 \cdot 12}{4 \cdot 12 \cdot 22} = \cdot 2 \text{ tons per square inch.}$$

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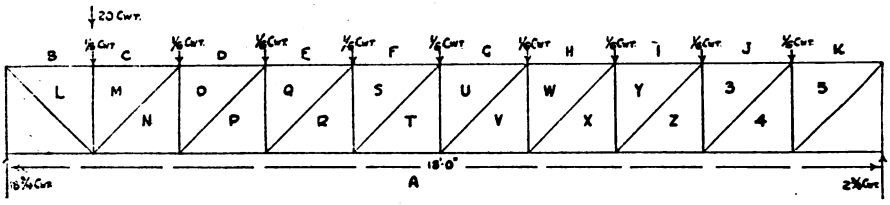
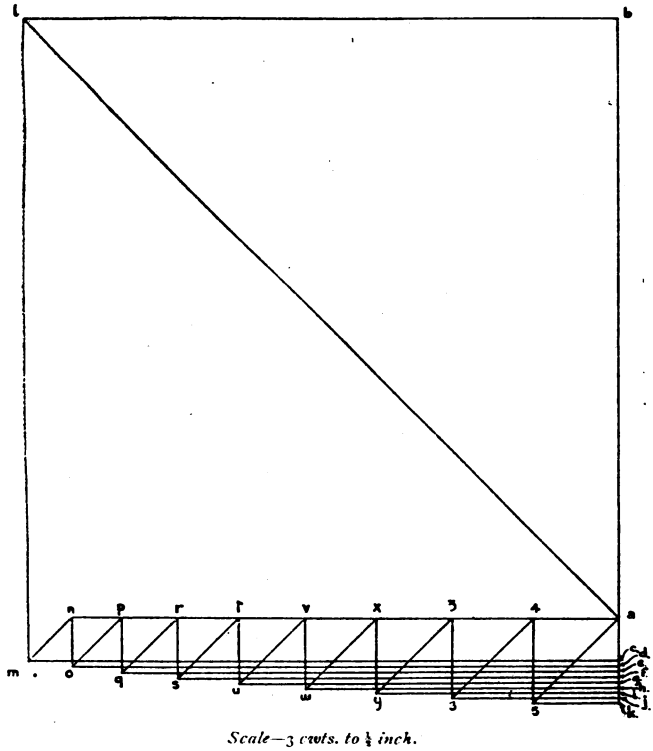


Scale—2 feet to ½ inch.



Scale—3 cwts. to ½ inch.

Stress Diagram for Light Section, No. 3 Girder.

Web.—The maximum stress with a heavy rolling load is over the 1st panel point.

This gives a load of 2486 lbs. in a piece of iron, the cross section of which is $2 \times \cdot0068 \times 1\cdot28$.

$$\therefore \quad \text{stress} = \frac{2940}{2 \times \cdot0068 \times 1\cdot28 \times 12} \text{ lbs. per square inch}$$

$$= 14{,}000 \text{ lbs. per square inch.}$$

(Breaking strain of this thin iron is 65,800 lbs. per square inch.)

$\therefore$ Above gives factor of safety of 4·7.

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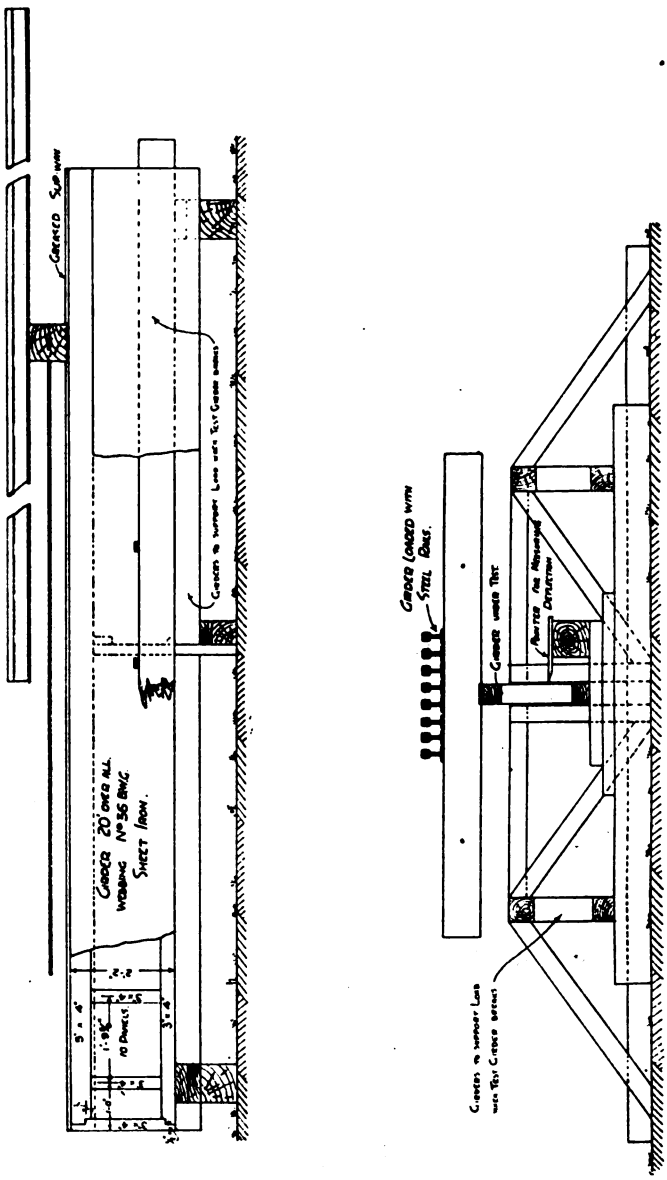
Attachment.—One 1½ in. clout nail per inch run along booms (see pages 334 and 335 *re* nails).

Test.—Fig. 4.—The girder was arranged as shown in *Fig.* 4 and loaded with steel rails, balanced on a 9 in. × 9 in. baulk, which was hauled along the girder by a traction engine. The load was pulled from one end to the centre, then stopped, the load increased, and pulled to the end.


Girder 20' 0" c. to c.
Webbing No 36 B.W.G. Sheet Iron.
Girder Loaded with Steel Rails.
Girder under Test.
Girders to support Load when Test Girder breaks

Scale—½ inch to 1 foot.

FIG. 4.—*Test of Light Section, No. 3 Girder.*

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Fig. 5.—Deflections were taken and plotted against load, *Fig.* 5.

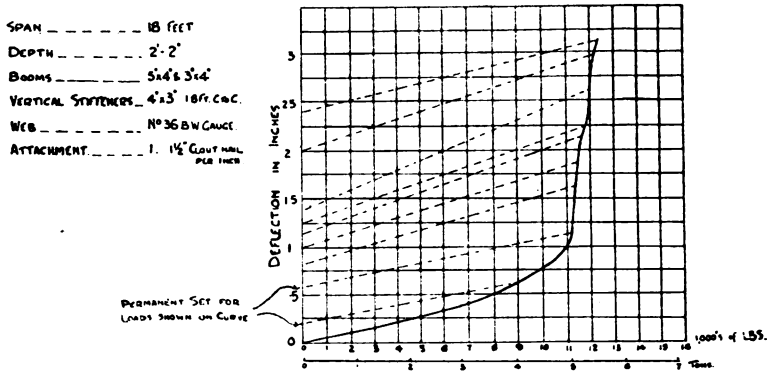

SPAN _ _ _ _ _ _ 18 FEET
DEPTH _ _ _ _ _ 2'-2"
BOOMS _ _ _ _ _ 5"x4"& 3"x4"
VERTICAL STIFFENERS _ 4"x3" 18ft. C.to C.
WEB _ _ _ _ _ _ N°36 B.W.GAUGE.
ATTACHMENT _ _ _ 1. 1½" CLOUT NAIL PER INCH
DEFLECTION IN INCHES
PERMANENT SET FOR LOADS SHOWN ON CURVE
1000's of LBS.
TONS.

FIG. 5.

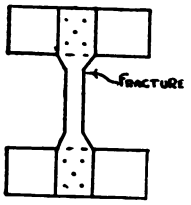
The girder supported up to 12,476 lbs. (5 tons, 11 cwt., 44 lb.) in the centre, but failed when the load reached the 1st panel point, through the web tearing away from the nails.

Very thin iron as used in this girder must be carefully selected, as a large proportion of the iron, when supplied, is rusted through.

Iron Plates for Webbing and Strength of Nails.

Iron plate ·0068 in. which is No. 37 gauge.

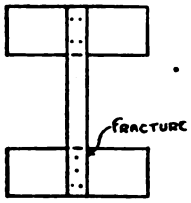
Test 1.—A strip of this plate, 2 in. wide, and larger at each end, which was held with five 1½ in. clout nails, broke under a load of 895 lbs.



Area at break = ·0068 × 2 square inches.

∴ Breaking strain per square inch

$$= \frac{895}{\cdot 0068 \times 2} \text{ lbs.} = 65{,}809 \text{ lbs.}$$



Test 2.—Three strips of iron, 2 in. wide, were placed on top of one another and nailed to pieces of 6 in. × 6 in. with four 1½ in. clout nails at each end.

The strips broke through a nail hole at a load of 2361 lbs.

This shows that the attachment was stronger than the strip. (2 nails per inch).

Test 3.—Same as before, but only 1 nail per inch.

The nails pulled out thus at 1400 lbs. (700 lbs. per nail).

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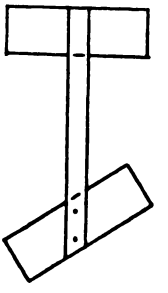
Test 4.—As above, but 1½ nails per inch pulling diagonally thus :—

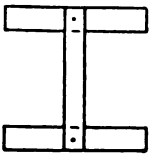


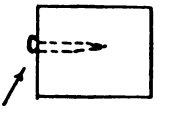
Nails pulled out thus ◺ at 2100 lbs. (700 lbs. per nail).

Therefore it appear that one 1½ in. clout fails by drawing out at 700 lbs.

The following further tests have been carried out on the strength of nails :—

A strip of sheet iron, 1 in. wide and ·048 in. thick (No. 18 gauge) was fastened to two blocks of wood with one 2½ in. wire nail at each end.





The nail failed by drawing through the iron at 1400 lbs.

This load caused the nail head to move ⅜ in. but did not draw it appreciably.

A similar strip, 1 in. wide, was fastened at the top with four 1½ in. clout nails, and at the bottom with two 2½ in. wire nails.

The 4 clouts failed by drawing at 2040 lbs.=510 lbs. per nail.

(My previous experiments gave 700 lbs. per ½ in. clout, but they were in hard wood, whereas these were in deal).

Four 2½ in. wire nails were put in place of the 4 clouts.

On increasing the load the strip broke at 2200 lbs.*

Cross-sectional area of strip=·048 in.

Breaking strain was 45833 lbs. per square inch=20·5 tons per square inch.

The experiments with No. 37 gauge (·0068 in.) iron showed that its breaking strain per square inch was greater than thicker material.

* This gives 1½ nails per inch run at right angles to pull or 1 nail per inch run at 45°, *i.e.* along the booms of girders

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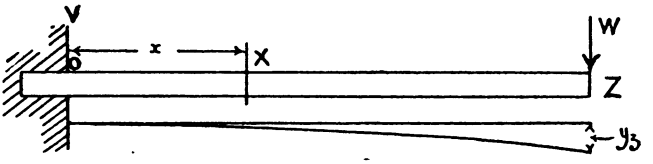
APPENDIX.

Uniform Cantilever Simply Loaded.



A.—A concentrated load W at the free end.

Take the origin O at the fixed end.

Then for $x = O$, $\frac{dy}{dx} = i_v$ and $y = O$.

At any point x the bending moment—

$$EI \cdot \frac{d^2y}{dx^2} = W(l - x).$$

$$EI \cdot \frac{dy}{dx} = W(lx - \tfrac{1}{2}x^2) + EIi_v.$$

$$EIy = W(\tfrac{1}{2}lx^2 - \tfrac{1}{6}x^3) + EIi_v x.$$

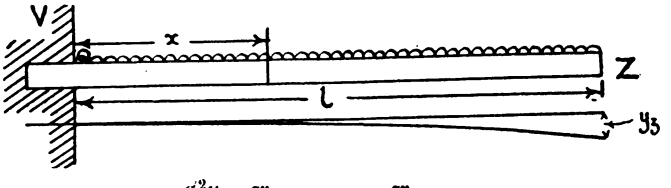
At the end Z—

$$\left(\frac{dy}{dx}\right)_3 \text{ or } i_z = \frac{W}{EI}(l^2 - \tfrac{1}{2}l^2) + i_v = \frac{Wl^2}{2EI} + i_v \quad \ldots\ldots\ldots(a).$$

and

$$v = \frac{Wl^3}{EI}(\tfrac{1}{2} - \tfrac{1}{6}) + i_v l = \frac{Wl^3}{3EI} + i_v l \ldots\ldots\ldots\ldots\ldots\ldots(b).$$

B.—Uniformly distributed load W per unit length. Origin O at fixed end.



$$M = EI\frac{d^2y}{dx^2} = \frac{w}{2}(l - x)^2 = \frac{w}{2}(l^2 - 2lx + x^2).$$

$$\therefore \quad EI\frac{dy}{dx} = \frac{w}{2}(l^2x - lx^2 + \tfrac{1}{3}x^3) + EIi_v,$$

and

$$EIy = \frac{w}{2}(\tfrac{1}{2}l^2x^2 - \tfrac{1}{3}lx^3 + \tfrac{1}{12}x^4) + EIi_v x.$$

For $x = l$—

$$i_z \text{ or } \left(\frac{dy}{dx}\right)_3 = \frac{wl^3}{2EI}(1 - 1 + \tfrac{1}{3}) + i_v$$

$$= \tfrac{1}{6}\frac{wl^3}{EI} + i_v \text{ or } \tfrac{1}{6}\frac{Wl^2}{EI} + i_v \ldots\ldots\ldots\ldots\ldots\ldots(c).$$

Where $W = wl$.

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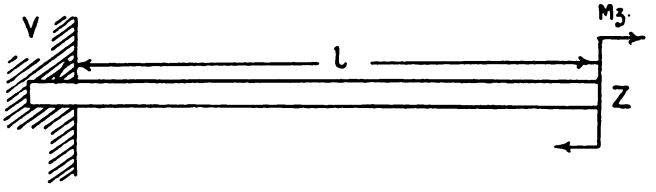
Also $$y_3 = \frac{wl^4}{2EI}\left(\tfrac{1}{2} - \tfrac{1}{3} + \tfrac{1}{12}\right) + i_v l$$

$$= \tfrac{1}{8}\frac{wl^4}{EI} + i_v l \text{ or } \tfrac{1}{8}\frac{Wl^3}{EI} + i_v l \quad \ldots\ldots\ldots\ldots\ldots\ldots (d).$$



C.—Bending couple M at Z

$$EI\frac{d^2x}{dx^2} = M$$

$$EI\frac{dy}{dx} = Mx + i_v EI$$

$$EIy = \frac{Mx^2}{2} + i_v x EI + O.$$

At Z

$$\therefore \quad \frac{dy}{dx} \text{ or } i_z = \frac{Mx}{EI} + i_v \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (e).$$

and $$y_3 = \frac{Mx^2}{2EI} + i_v l \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (f).$$

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DIRECTORATE OF INLAND WATERWAYS AND DOCKS.

THE following account of the work of the above, dated May, 1918, we are enabled to print by the courtesy of the Director :—

GENERAL.

The Directorate of Inland Waterways and Docks is an entirely new branch of the War Office which has been created to fill requirements arising out of the present war.

It was very early realized that it would be necessary to take the fullest advantage of the canal and river systems in France and Belgium as a means of transportation supplementary to rail transport. The waterways were therefore developed energetically in the French and Belgian theatres, and steps were taken to form an organization to control these waterways in the British zone of operations, and also to maintain them in the highest possible state of efficiency, in order to relieve the railway as far as possible in respect of the transport of war material, stores, etc. This has been carried out very successfully, and whereas for the quarter ending March, 1917, a total tonnage of war material, etc., was carried amounting to 345,439 tons, for the quarter ending March, 1918, it had increased to 672,516 tons.

The supply of *personnel*, craft, and material was made from the War Office originally, as a small branch of Q.M.G. 2. As the work increased both in France and in other theatres of war, a separate Directorate was formed, as at present constituted, under the administrative supervision of the Director-General of Movements and Railways.

RICHBOROUGH.

A Depôt for *personnel* was formed near Sandwich, and from this locality also barges, acquired for the Inland Water Transport in France, were equipped, manned, and despatched. A Stores Depôt was also inaugurated for the supply of urgent and necessary stores. So far, therefore, the establishment at Richborough dealt solely with the functions enumerated above, *i.e.*, a draft depôt for *personnel* and a Stores Depôt.

Owing to the convenience of dealing with these matters under one control, it was decided to add the finding of stores and *personnel*

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for the Directorate of Docks in France, which was established for the proper control and co-ordination of dock working at the Ports which were allotted for the use of the British forces. To this again was added the supplying of *personnel* and stores for the Directorate of Port Construction, which was subsidiary to the Docks Directorate, and which dealt with additions to and the upkeep of the wharfage and dock accommodation.

The next step in the development of Richborough arose owing to the fact that it became increasingly difficult to get barges built sufficiently quick to meet the needs in France, in consequence of congestion in the shipyards. A scheme was therefore commenced by which barges were constructed at works where water and slipways were not available. These barges were then railed down in plates and angles to Richborough where slips were constructed and the barges entirely put together and equipped. This was still further extended, as the shipping position became more acute, by the complete construction of barges, material being sent straight from the rolling mills to Richborough. Under this schme it was possible to keep pace with the demands for craft. It necessitated the erection of workshops, power-plant, etc., and resulted in fact in up-to-date shops, and barge-building yard entirely under Military control.

More recently this yard has undertaken the construction of special types of small craft required by the Admiralty in connection with the towage of seaplanes, and which could not be conveniently built either in civilian or Admiralty yards. The undertaking of this work has been very successful.

The adoption of these measures necessitated a supply of skilled *personnel*. At the commencement, this *personnel* was found from drafts awaiting despatch overseas, and the employment and training of these men very materially enhanced their value when finally despatched. It was not possible, however, to carry on the work with these drafts only, and a permanent establishment was therefore set up in connection with the craft construction programme.

The *personnel* for this purpose was enlisted in the Corps, but the highly skilled trades were not largely drawn upon—a nucleus only of skilled men being engaged—the majority of the *personnel* consisting of totally unskilled or semi-skilled men who were trained by means of Schools of Instruction and gradually turned into skilled tradesmen. This resulted in a very large and satisfactory amount of " dilution upwards " being carried out.

The establishments of workshops, power, plant, etc., originally intended only for barge construction, made it possible to undertake other urgent work instead of having to depend upon the civil engineering shops, which were very fully employed with orders

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for the Ministry of Munitions, etc. A large amount of work is therefore done now at Richborough which would otherwise have to be placed in civilian shops, in connection with the maintenance of docks, wharves, and canals in the various theatres of war. The advantage of this has been quite recently emphasized when the Richborough shops were able to accept urgent work such as repairs to Tractor Locomotives, etc., which owing to military operations could not be carried out in the war area. Richborough is becoming in effect a base workshop.

The above deals with one side of the Richborough Depôt, but there is another side which is becoming even more important, and which developed incidentally out of the original beginnings, *i.e.*, its value as a transport Depôt. When the shipping position began to assume a serious aspect, it was realized that a good deal of relief could be afforded by using barges and tugs for the transport of war material to France. A special type of barge was therefore designed and built, of sufficiently seaworthy construction to stand the cross-channel passage, and at the same time of suitable dimensions to enter the French canals and so supplement the Inland Water Transport already existing.

The advantages of this means of transport are obvious, quite apart from the actual relief of sea-going ships. They are briefly as follows :—

(*a*). The dispersal of both marine and war risks into smaller units.
(*b*). Facilities of loading.
(*c*). The relief of dock congestion owing to the fact that the barges passed right through the docks into the interior.
(*d*). The saving of double handling, the barges being discharged at an inland depôt.
(*e*). The saving of railway carriage in France.
(*f*). Comparative immunity from enemy torpedo attack owing to their shallow draft.

In order to conduct this service efficiently, it was necessary to provide adequate wharfage accommodation at Richborough. The small amount of wharfage that was in use for the equipment and despatch of the original French canal barges was therefore very largely extended. A wharf was constructed with all the necessary crane facilities, and this is being gradually expanded to handle 6,000 tons of dead-weight per diem, and the barge fleet is being augmented up to this figure.

When the service first commenced in December, 1916, the amount of tonnage transported to France during that month was 2,090 tons. In March, 1918, it amounted to 67,697 tons. Even so, the figures do not actually represent the increase, as originally only dead-weight cargo such as rails and heavy stores were handled, but at

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present all classes of war material are carried, including such light cargoes as hay, aeroplanes, etc., which give a very poor dead-weight result, although the service rendered is quite as useful.

The latest development of the barge service is in the direction of 1,000 ton barges, as the limit of the canal capacity has been reached with the smaller barges. These 1,000 ton barges will be discharged in the docks in France, and although therefore they do not possess the advantages enumerated above as regards the canal craft that go into the canals, yet, at the same time, they are a direct relief to shipping.

In addition to the tonnage exported from Richborough to France, a very large amount of salvage is being transported in the return barges, as well as large quantities of material for repair purposes, etc. The amount of salvage brought back up to March, 1918, for return to the filling factories is 62,601 tons.

A still further development in the way of transport has occurred by the institution of a system of Train Ferries. These ferries are operated between Richborough and Calais or Dunkirk, and also between Southampton and Dieppe. As regards the Richborough service, a terminal has been constructed at Richborough, and the necessary dredging operations undertaken to deepen the channel. This dredging is still going on, but will be shortly finished.

The Train Ferry service is an entirely new departure in sea transport so far as Great Britain is concerned, and during the time the ferry boats have been in operation they have proved of the greatest value. They are operated by means of an electrically-lowered shore bridge which connects with the deck of the steamer, and enables a complete train of 54 ten-ton wagons (or other stock in proportion) to be run straight on board the ferry, and similarly discharged on the French side where terminal facilities have also been constructed. The operation of loading and unloading these vessels averages about twenty minutes only and the passage across channel occupies about one and a half hours. A detailed note of this ferry system is attached (Appendix " A.").

This concludes the detail of the direct functions of the Richborough Depôt, but in many subsidiary ways it is used for the various undertakings of the Directorate for the supply of *personnel*, stores, etc., for other theatres of war as well as for home demands.

Poplar Depot.—A small Depôt was formed on the Thames at Poplar in December, 1915, with a sub-depôt at Gravesend for the alteration, repair, and maintenance of second-hand craft purchased for the requirements of the Directorate at Home and Overseas. This Depôt is also responsible for the provision of crews for new and second-hand craft from the various builders' yards round the coast to Richborough.

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Glasgow Depot.—A Depôt was formed in Glasgow early in 1917 for the equipping, victualling, and manning of all the craft for service in the East. Officers and men complete their training at this Depôt prior to being drafted Overseas as crews of Mesopotamia, etc., craft.

The use of Inland Water Transport has not been confined to France, and the duties of the Directorate have been increased from time to time to include development and supervision over Inland Water Transport in other directions, as follows :—

MESOPOTAMIA.

When the War Office assumed control of the operations of the Mesopotamia campaign, the water lines of communication were organized under Inland Water Transport Directorate. The functions of the headquarters at the War Office consist of a supervision of policy ,the supply of European *personnel*, river craft, including hospital ships, etc., in fact, the interests generally of the river route, which is the principal Line of Communication of the Mesopotamia Expeditionary Force. The tonnage handled up the river by the I.W.T. has increased from 222,275 tons for the quarter ending March, 1917, to 464,196 tons for the corresponding quarter in 1918, and in addition to this, large numbers of troops, prisoners of war, and horses have been carried. The I.W.T. Directorate also control Port working at Basra, have carried out large wharfage schemes, and have executed a comprehensive scheme of River buoyage and conservancy. A general summary of the work done is attached (Appendix " B ").

EGYPT.

The development of Inland Water Transport in this theatre has also been undertaken by the Directorate. This work includes extensive use of the Nile and the Canal system of Lower and Upper Egypt, and also the lighterage of ships at ports such as Alexandria and Port Said, and more recently at the Port of Kantara, which is the base from which the army in Palestine is supplied. The more recent returns shew that 181,886 tons of actual river transport were carried, and 280,444 tons of lighterage during January and February, 1918.

EAST AFRICA.

The operations of the Directorate in this theatre have been small when compared with the others, but very useful work has been done by the development of coastal waterways, and also in connection with the Port work.

SALONIKA.

In this Port the I.W. & D. undertook and are carrying out the discharge of ships.

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Taranto.

The Directorate supplies all craft for use at Taranto, and in addition cranes and other Port equipment have been provided.

Cranes.—The carrying out of these large and varied undertakings necessitated the development of certain special branches in connection with the supply of material: in particular cranage. It was early realized that any successful working depended to a very great extent on adequate cranage facilities wherever ships or barges had to be loaded or discharged. There was a great scarcity of available cranes in the country, and a census was taken of practically all cranes in the country, and as many as possible were acquired. In consequence there has never been any real difficulty in keeping the requirements for cranes supplied. When the supply of second-hand cranes became exhausted, the matter had to be considered with a view to coming to a decision as to the best method to be adopted to meet the situation, the crane makers' works being fully occupied, and any quick delivery being almost impossible. It was therefore decided to design and construct a standard crane. The various parts were manufactured wherever facilities could be obtained, and sent to Richborough, where they were assembled, put together, and tested. A description of this crane, which has proved to be a great success, is attached (Appendix " C ").

No fewer than 645 cranes have been supplied by the Directorate up to April 30th, 1918, in fact, such an expert knowledge of the cranage conditions was obtained that requests have been made to us to supply various other Departments quite outside the activities of the Directorate, and recently to supply the American Government with cranes for their use in France (*See* Appendix " C ").

Filtration Plant.—Another phase is the design and supply of Filtration plant, particularly to Mesopotamia and France. The Directorate has supplied no fewer than 32 of these plants and this work has been of the greatest utility and importance (*See* Appendix " D ").

Pneumatic Grain Handling Plant.—The Directorate has also been responsible for the supervision of the construction of eight Pneumatic Grain Handling Plants for use at the French Ports (*See* Appendix " E ").

Construction Works.—The highly technical staff of Engineer Officers and others attached to the Directorate for the carrying out of constructional and engineering works have been employed in other directions in addition to the development of Richborough and other I.W. & D. bases. The military labour employed in connection with these works also became well qualified and skilled, and gained a reputation for celerity and efficiency.

During 1917 it became necessary to expedite as much as possible the building of aerodromes for the rapidly-growing needs of the

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Air Force. In certain localities it was found very difficult to obtain civilian workmen, and the Directorate were therefore asked to undertake large building operations in this connection. This was done by adding to the staff of Engineers, and also by withdrawing from Richborough a nucleus of skilled workmen. It was also necessary to further enlist men in order to obtain the necessary labour required for the carrying out of these works. The following camps were undertaken :—

Manston.—A very large camp accommodating 200 officers and 3,120 men, together with 5 hangars, technical buildings, gymnasium, etc., amounting to approximately 15,882,000 cubic feet of building work.

Eastchurch.—A similar camp to Manston, accommodating 175 officers and 960 men, also technical buildings, institutes, etc., amounting to 3,665,000 cubic feet of building work.

Salisbury Plain.—Three large aerodromes with the necessary living accommodation, instructional buildings, etc., amounting to approximately 17,510,000 cubic feet of building work.

Hawkinge (near Folkestone).—Aerodrome, quarters, technical buildings, etc., accommodating 600 officers and men, amounting to approximately 5,573,000 cubic feet of building work.

National Shipyards.—The Admiralty were desirous of immediately starting the construction of National Shipyards on the Severn and Wye Rivers, but had no organization to commence the work. The whole of these large works were therefore undertaken by this Directorate, and were carried up to a point when the Admiralty were in a position to take over the work. The value of the work performed by this Directorate amounted roughly to £766,000.

HEADQUARTERS ORGANIZATION.

The organization of the Directorate to carry out the work as outlined above is as follows :--

AT THE WAR OFFICE.—11 Sections (as below), directly controlled by the Director Inland Waterways and Docks, 1 Deputy Director, with Assistant Directors, Deputy Assistant Directors and staff.

Administrative.—General administration and supervision, M.R.3.A. (supervised by an Assistant Director).

Mechanical Engineering.—Mechanical engineering and dock equipment for overseas, M.R.3.B. (supervised by an Assistant Director).

Purchasing.—Fulfilment of requisitions for plant, stores and material for home and abroad, M.R.3.D. (supervised by an Assistant Director).

Traffic and Marine.—Movement of I.W. & D. craft, operation of cross channel and coastwise barge services and train ferries : movement by rail and water of I.W. & D. stores and materials. Craft requirements for home service and overseas, alteration, repair and

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maintenance of home service fleet, equipment and outfit of new vessels, M.R.3.E. (supervised by an Assistant Director).

Personnel.—*Personnel* for I.W. & D. Services, M.R.3.F. (Deputy Assistant Director).

Civil Engineering.—Civil engineering, design, plans, supervision of I.W. & D. construction work in England, engineering questions arising from I.W. & D. construction work overseas, M.R.3.G. (Assistant Director).

Finance.—Finance supervision and statistics, scrutiny and checking of accounts before submission for payment: preparation of works costs of I.W. & D. works, M.R.3.H. (Deputy Assistant Director).

Statistical.—Records and statistics, M.R.3.J. (Senior Officer—Captain).

Plant Record.—Record and control of all plant, acquisition, control, and disposal of hired plant, M.R.3.L. (Senior Officer—Major).

General Office Supervision.—General office supervision, M.R.3.M. (Deputy Assistant Director).

Inspection.—Inspection of plant, machinery and general stores under acquisition, M.R.3.O. (Deputy Assistant Director).

AT RICHBOROUGH.—7 Sections (as below), under a Deputy Director, 1 Assistant Director, with Deputy Assistant Directors, and staff:—

Depôt.—Commanding Officer (Lieut.-Colonel).

Mechanical Engineering.—Commanding Officer (Colonel).

Construction.—Commanding Officer (Lieut.-Colonel).

Traffic.—Commanding Officer (Lieut.-Colonel).

Marine.—Commanding Officer (Lieut.-Colonel).

Stores.—Commanding Officer (Major).

Accounts.—Commanding Officer (Deputy Assistant Director).

At Glasgow.—1 Assistant Director and Staff.

At Poplar.—1 Senior Officer (Major) and Staff.

At Southampton.—1 Senior Officer (Major) and Staff.

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APPENDIX A.

CROSS-CHANNEL TRAIN FERRY SERVICE.

THE foregoing *Report upon Train Ferries as a means of transportation and their adoption in various countries was prepared early in 1917 for the Directorate of Inland Waterways and Docks at the War Office as a basis for the consideration of a scheme for a Cross-Channel Train Ferry Service which had been submitted to the War Cabinet as an urgent war measure.

Before this scheme received sanction, various difficulties and objections had to be overcome. Although train ferries had been successful in other parts of the world, it did not follow that they would operate well in the Channel with its tidal range and other well-known characteristics. Moreover, regularity of service was an important factor, and under war conditions this could not be counted upon owing to mines and other forms of enemy activity, and to the precautionary measures rendered necessary in consequence.

The advantages gained by the saving in handling of the materials to be carried would undoubtedly be considerable, but somewhat elaborate arrangements would have to be made for the return of the wagons used (loaded, if possible, with salvage or materials for repair, etc.) as it was evident that British rolling-stock could not be indefinitely passed over into France.

A more serious objection, urged by the Admiralty, was that the vessels themselves, being necessarily of a special nature, would take a long time to build, thus interfering with the construction of urgently needed mercantile tonnage.

Eventually, however, it was decided that the advantages of being able to rush through any particular materials direct from the works in England to the fighting forces in France without intermediate handling, the ease of transportation of heavy loads such as locomotives, tanks, heavy guns, etc., and their return to England for repair, were so great that the scheme should be adopted and the necessary work put in hand with all speed.

Instructions were accordingly given on 17th January, 1917, that three ferry steamers should be built, terminal ports selected, and the necessary berths and other works pressed forward. Two routes were decided on, a northerly and a southerly—the latter being available in case of serious interruption to the former.

*A technical Report on the general use of Train Ferries in other countries—(not included.)

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Choice of Terminals.

English Ports.—Two sites were chosen : one on the south-east coast at Richborough, and the other on the south coast at Southampton. In selecting the English terminals, careful and exhaustive consideration was given to all suitable sites. The advantages of using old-established ports, such as Ramsgate, Dover or Folkestone on the south-east coast, were fully weighed, but there were many difficulties owing to their already congested condition and lack of space for the sidings involved.

Richborough had already been considerably developed as the home depôt of Inland Water Transport operations and the base of the cross-channel barge service of munitions and materials of war. The whole area was under the military control of the authority which would build and operate the ferry service, railway connections already existed, ample space was available for sidings, and the necessary labour force, under skilled direction, was ready at the site. Instead of injuring commercial interests, or adding to existing congestion in a busy mercantile or naval harbour, the construction of the ferry terminal at Richborough would assist in the development of the port.

Southampton was decided upon as the south coast terminal after conditions at Portsmouth, Itchen River, Hamble River, Langston Harbour, Chichester Harbour, and Keyhaven had been examined and considered. The most suitable site at Southampton was found to be immediately west of the Royal Pier. At that spot very little dredging was required, the position was sheltered and out of the way of shipping, and there was ample room in which to turn the ferry steamers. The necessary sidings could readily be constructed along the foreshore on reclaimed ground and a connection made with the main line of the L. & S.W. Railway at Southampton West Station.

French Ports.—Three ports were selected on the French coast, namely, *Dunkirk*, *Calais*, and *Dieppe*. These sites were determined after thorough consideration of all available ports along the French coast between Havre and Belgium. In many cases the ports were already congested or sea access was unsuitable, and even in the case of the ports chosen these difficulties could not be entirely obviated.

The distance from Richborough to Dunkirk is about 54 miles, while to Calais it is about 35 miles. The distance from Southampton to Dieppe is about 130 miles.

Terminal Works.*

Bridges.—The communication bridges at all five ports were all built upon the same principle, and differed only as regards length, the latter being governed by the tidal conditions. The various spans measured from centre to centre of bearings were as follows :—

* The works at the various ports were practically complete by the end of 1917, the boats having been completed previously. Traffic commenced to be sent from Southampton in November, 1917, and a regular service between the various ports was running early in 1918.

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	ft.
Southampton and Dieppe	120
Richborough and Calais ...	100
Dunkirk	80

Each bridge carries two railway tracks set to 11ft. 6in. centres, the gauge being 4ft. 8½in., which will take both British and Continental stock. The structure was made to clear the modified Berne or standard Continental leading gauge.

Each bridge consisted of two main N-type girders joined by cross-girders secured to the main girders by means of pins, the joints giving the necessary flexibility to allow the bridge to adapt itself to a heel of about 5° in either direction in the steamer. The bridges are carried at the land end on two hinged bearings and on the steamer by means of two hemispherical bearings to allow for movement due to rise and fall of tide and heel of ship during loading, the sea end connections being identical for all five bridges.

The tower from which the bridge is suspended consists of two legs 42ft. high, each about 5ft. 6in. square, and placed 36ft. 6in. apart between centres, connected at the top by a double webbed plate girder upon which the actuating winch and machinery are erected. The bridge is suspended between the tower legs by four ropes working on counter-weights suspended in the tower legs, timber rubbing pieces being provided to prevent fouling. The tower legs are stiffened in the longitudinal direction of the bridge by raking struts and bracing. The feet of the towers rested upon piers placed in all cases 4ft. below rail-level on land.

The operating machinery works in a steel cabin on the top of the connecting cross girder on the tower and consists of a 20 B.H.P. electric motor running at 500 r.p.m. and driving through work and spur gearing the cast iron grooved rope drum. Hand gearing is provided by which the bridge can be raised or lowered in case of a breakdown in the electric machinery. The gear can easily be operated by two men.

Illustrations in plan and section of the bridge and jetty, showing boat connections, are appended.

Berths, etc.—The selection of Richborough as a terminal involved the dredging of the entrance to a depth of about 10ft. below L.W.O.S.T. and the cutting of a new channel 200ft. wide at the bottom. The site chosen for the berth is situated between the end of Richborough Wharf and the sea : its distance from the sea was about 5,000 yards. This has been reduced by the dredging of the new channel to about 3,200 yards. A turning basin 500ft. wide is provided close to the berth in which to swing the steamers. The berth itself was dredged to 16.50 O.D. in order to accommodate the vessels at all states of the tide.

The berth was constructed as a timber jetty with arms on each side of the ship : the one on the port side was made 420ft. long by 26ft. wide, while the other on the starboard side is about 130ft. long by 50ft. wide. The jetties were built of timber piles 12in. square, spaced 10ft. apart between centres, and driven down to about 20.00 O.D. into firm sand. The piles are well braced in both directions, and alongside the port jetty a line of steel sheet piling was driven to hold the ground.

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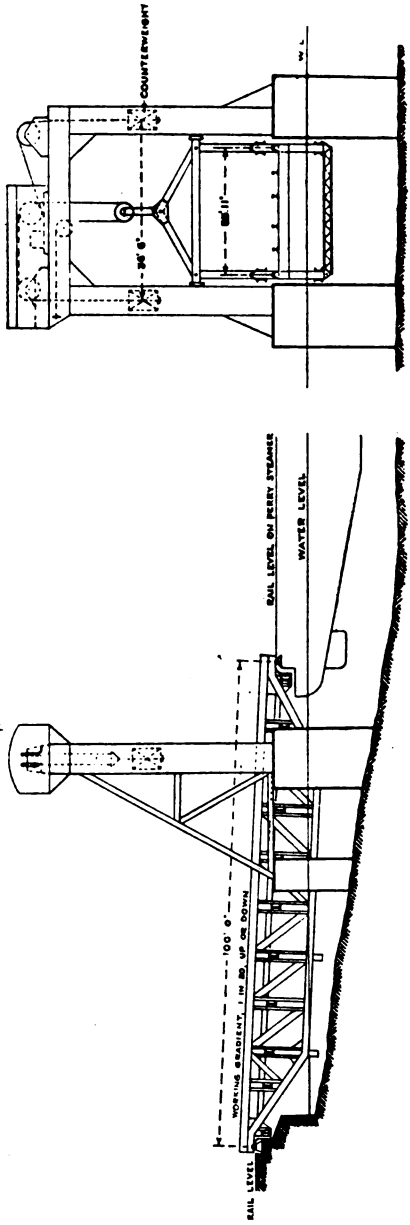
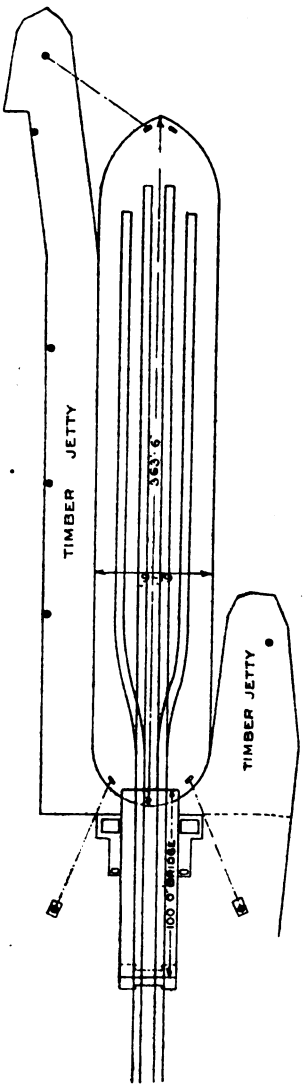
TRAIN FERRIES.

General Arrangement (Small Scale).



Scale, ½ inch = 20 feet.

Diagram of Berth and Bridge.



Scale, ½ inch = 50 feet.

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A system of sidings for dealing with the train ferry traffic was laid down close to the berth and connected to the main access sidings at Richborough by means of a short length of single line, the whole system being situated near Minster Junction on the S.E. & C. Railway. Each set of ferry sidings can accommodate a complete boatload of inward or outward traffic, and two shunting locomotives work between the sidings and the boat, back shunting or hauling two trains or wagons simultaneously.

Opposite the ferry sidings four oil-fuel tanks were erected, each capable of storing about 525 tons of oil. A small pumping station was built close by, and a pipe-line laid to the port side of the jetty. By this means the oil tanks on the steamer can be filled in about half-an-hour.

At Southampton the natural conditions were considerably simpler than at Richborough. The access to the site was good, and the only dredging necessary consisted in a triangle area leading into the berth, which was dredged to about 22.00 O.D. The berth itself was dredged to 26.00 O.D.

The berth is accessible at all states of the tide, the tidal range being 13ft. The berth itself was constructed on the same lines as Richborough, modified to suit the site. The long arm was arranged on the starboard side of the vessel so as to be easy of access from Southampton Water: it was made 450ft. long by 35ft. wide, the short arm on the port side being 110ft. long by 35ft. wide. The piles were well braced in both directions and were arranged so that, if necessary, the starboard jetty could easily be widened to accommodate a second boat on the opposite side of the first one.

The land end of the communication bridge is situated about 1,000ft. seaward of the existing foreshore wall. If the berth had been built nearer the shore, dredging would have been increased, and constant work would have been required to keep it free from silt. As a war measure it was decided to bridge the intervening gap by a timber viaduct, the length being reduced as much as possible by forming an embankment at the shore end. The bank carries, besides the rails, a motor road 20ft. wide, a portion of the ferry sidings, and also a scissors crossing. The timber viaduct is 630ft. long by 24ft. wide, and carries a footpath as well as the two railway tracks.

The sidings were formed partly on the embankment and partly on the site of the obsolete West Quay and several small slips and yards. They are about 700ft. long and consist of four tracks, two for outward and two for inward traffic. In addition to the ferry sidings and between them and the West Station two reception sidings were formed, each about 1,100ft. long, and able to take a complete boatload of wagons and main line engine.

Connection is made with the L. & S.W. Railway on the west side of the Station. Four oil-fuel tanks were provided opposite the sidings, with pumping station and pipe line, as at Richborough. A water supply and electric cables for power and light were also installed.

Whilst these works were proceeding at Richborough and Southampton, similar terminals were being built at Dunkirk, Calais and Dieppe, modifications being necessary owing to the conditions at each port. As stated, the communication bridges are similar to those at the English

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ports. The works at all the French ports were carried out by military labour with the assistance of Chinese coolies. Very few of the soldiers were skilled men, so practically all the men employed had to be trained to their duties as the work progressed.*

FERRY STEAMERS.

The Cross-Channel Ferry fleet consists of three vessels. The principal dimensions are :—

	ft.	in.
Length (over all) ...	363	6
Breadth (over fenders) ...	61	6
Depth moulded ...	17	0
Draught (loaded) forward	9	0
Draught (loaded) aft ...	10	0

Speed, approximately 12 knots.

Four lines of rails are laid on the deck, capable of taking 54 ordinary 10-ton wagons or their equivalent in other stock : the total specified deck load is 850 tons, and the total dead weight, including stores, spare gear, water and oil fuel, is 960 tons. The total length of track available for the storage of wagons is 1,080ft. One of the ships is fitted with timber tracks to take the wheels of motor lorries; from 50 to 60 of these vehicles can be accommodated at one time.

The propelling machinery consists of two sets of triple expansion engines, supplied with steam at 180 lbs. pressure by four single-ended boilers, fitted with Howden's forced draught arrangement and oil-firing appliances. The boilers are arranged in pairs on each side of the vessel, with two oil-fuel tanks between them on the centre line of the ship. Oil fuel was decided upon instead of coal; this permitted the boilers to be reduced in diameter, thereby allowing the moulded depth and consequent windage on hull to be reduced, as well as simplifying the bunkering arrangements. The tanks have a total capacity of about 80 tons at 38 cubic feet per ton. The funnels, two in number, are fitted on each side of the vessel, braced together near the top by means of a light lattice girder and guyed fore and aft.

The vessels are fitted with twin screws, and are cut away underneath for a length of about 50 feet at the stern, so that the screws and large balanced rudders placed between them have large manœuvring power. There is a single deck, on which the rails are laid. Near the stern this deck is cut away square and seatings provided for the ship end of the communication bridge to rest upon. The fore and aft peaks are built as ballast tanks, with a capacity of 160 tons forward and 210 tons aft, two wing tanks of about 45 tons capacity each being also provided.

The main bridge is situated amidships and carries chart and wireless rooms and captain's quarters, the captain's bridge and wheelhouse being on top of these again. The wheelhouse contains the steam steering gear, telemotor control standard, wheel, and compass. A search-

* A plan and sections of the boats is appended.

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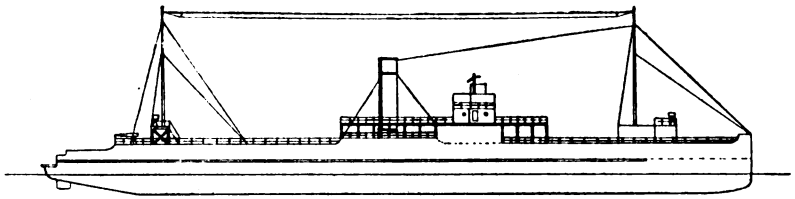
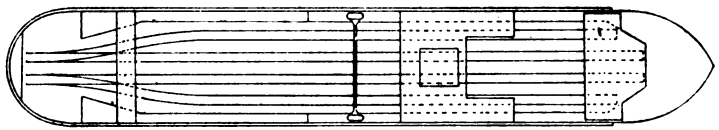
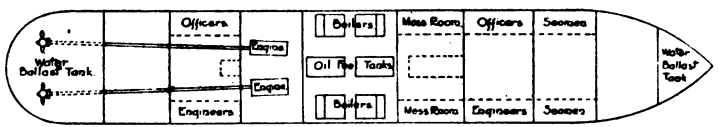
TRAIN FERRIES. STEAMER.



SIDE ELEVATION.

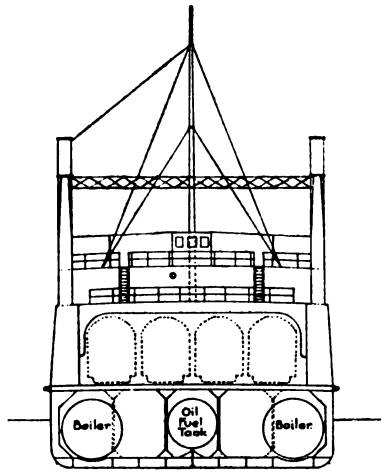


DECK PLAN.



ENGINE ROOM & ACCOMMODATION PLAN.

Scale. ½ *inch* = 50 *feet.*



SECTION LOOKING FORWARD.

Scale. ½ *inch* = 20 *feet.*

PRINCIPAL DIMENSIONS.

Length Overall	363′ 6″	Breadth Moulded	58′ 6″
,, Between Perps.	350′ 0″	Depth ,, ...	17′ 0″
Breadth Extreme over Fenders	61′ 5″	Draft Fully Laden, Forward 9′ 0″, Aft 10′ 0″, Mean 9′ 6″	

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light is mounted on top. A docking bridge is also provided aft in order to control the transfer of traffic. This bridge as well as the captain's bridge is fitted with telegraphs, control standard and other apparatus.

Two steam capstans are installed forward and two aft for mooring the vessel, and, if need be, for assisting the wagons on and off the boat; they are each capable of exerting a pull of twenty tons.

Accommodation is provided below deck for officers, engineers, and crew, the side structure on deck being utilized for companion ways, cooking galley, etc. The *personnel* on each vessel consists of the Captain, three executive officers, four engineer officers, one wireless operator, and about 37 petty officers, gunners, and men.

Four 12-pounder guns are provided on each vessel. If need be, 4·7in. guns can be fitted. Magazines are arranged below the water-line, with trunks and ammunition hoists. Various anti-submarine devices are also carried.

All three vessels were designed and two of them constructed by Messrs. Sir W. G. Armstrong, Whitworth and Co., Ltd., Elswick; the third vessel, in order to save time, was placed with Messrs. Fairfield, Govan, Glasgow. All three were built of mild steel in accordance with Lloyds' requirements for Channel service steamers under their special survey and official inspection.

Signalling.—The signalling arrangements are designed as a complete system depending upon the communication bridge and the steamer: when the bridge has taken its correct bearing on the steamer, a certain sequence of signalling operations automatically follow: and when the bridge is raised from the steamer, it is mechanically impossible to run traffic on to it.

Traffic.—Two of the ferry steamers are employed on the Richborough-Calais route, and the third one is operated between Southampton and Dieppe—the use of Dunkirk as a terminal port having been held over for military reasons. The sailings are determined by tidal and naval conditions. On the average a daily service is maintained between Richborough and Calais, and one sailing every 48 hours on the Southern route.

The control of the traffic, berthing and loading is in the hands of the Director of Inland Waterways and Docks at home, and in those of the Director of Docks at the French ports. The actual sailings are made under the current Admiralty regulations. The class of traffic carried is agreed upon each month by the Director of Movements in consultation with the Director of Docks.

The procedure adopted in order to secure the wagons on the ferry steamer is as follows:—

As soon as a line of wagons has been backed on to the ship, gangs of men apply all the brakes, and place a number of rail scotches in position, six to each track. When the boat has been completely loaded each wagon is made fast to the ship by four chain slings, one round each buffer casting, and shackled to ring bolts riveted to the deck. The slings are tightened up by means of union screws with fly nuts. Four jacks are then placed under each wagon at the corners of the body and its weight taken by them, thus relieving the springs of part of their load and preventing all oscillation during the sea passage. The time taken

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in these operations is twenty minutes to half-an-hour; to economize time the slinging and jacking is carried out while the vessel is getting under weigh, and the men put ashore either by the port tug or at the locks, according to the port concerned.

Experience has shown, however, that these security precautions are unnecessarily elaborate, and they are being modified accordingly.

Some particulars are appended of traffic at Richborough and Southampton carried by the train ferries to date. At the outset of the service, War Department trucks were carried for use in France, which had formerly been taken by ordinary steamer. In seven trips from Richborough 340 trucks were carried, and 631 trucks in 13 trips from Southampton. As a comparison of the utility of this service with ordinary shipping, it may be noted that a steamer of 3,600 tons d.w. carrying capacity could carry only 300 trucks in a month. It is calculated that, carrying heavy cargo such as tanks, guns, ambulance trains, motor transports, etc., the three boats will release six 8,000-ton ocean-going steamers hitherto entirely employed on this traffic—apart, of course, from the considerable saving in handling, etc., required by the ordinary method of double transhipment. The ferries are especially useful in regard to the carriage of heavy siege guns on their own mountings, which can be sent over intact and railed straight to the Front instead of having to be sent over dismantled and put together in France.

An addition to the train ferry fleet is now being acquired in the shape of the train ferry steamer *Leonard*, which until the completion of the Quebec Bridge carried passenger and freight trains between Quebec and Levis across the St. Lawrence at all seasons of the year. An exceptional feature of the vessel is that she has an elevating deck with a lift of 18ft. to meet the difference in tide-level. The principal dimensions are :—

Length over fenders	326	feet
Breadth moulded ...	65	,,
Depth moulded ...	23	,,
Mean depth loaded	15	,,

It is intended to run this boat from Southampton, where a second berth can easily be provided.

In view of the objections to the scheme put forward on the part of the Admiralty and the Ministry of Shipping, it may be noted that, in actual working, despite the very abnormal conditions and difficulties incident to naval restrictions which have prevailed since the inauguration of the service, the train ferries have proved satisfactory in every way and of the utmost value as a rapid and efficient means of transportation between England and France. As a war measure especially, the service has been fully justified by results already obtained, and under normal conditions of free and unrestricted running, it would be possible to maintain a constant "shuttle" service between all five ports, thus securing the greatest economy and efficiency in operation.

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RICHBOROUGH.

	OUT.			IN.	
	Feb.	Mar.	Apr. to 27th.	Mar.	to Apr. 27th.
Locomotives and tenders			14		11
(Petrol)		4			9
(Steam, narrow gauge) ...					42
(Electric)					6
Wagons, new	390	150	243		
(For return and returned) ...		616	450	419	660
Steam roller			1		
Guns and Carriages		286	248		
Tanks	1	35	92		
Timber, tons	856	2871	195		
Crane parts, tons		62	143		
R.F.C.		12			
Tank Corps (Tanks as above and Stores) tons	26	1251	3115		
Petrol, tons	714				
R.E. Stores, tons			141		
Hay			216		
Machinery					1264

SOUTHAMPTON.

	OUT.					
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr. to 27th.
Locomotives and tenders						4
Number of wagons, new	38	404	99	44	298	73
Ambulance wagons					16	48
Motor lories...						172
Motor vans					60	130
Cargo, tons					104	792

APPENDIX B.

MESOPOTAMIA.

In July, 1916, the War Office assumed control of the operations in Mesopotamia, and in September, 1916, the I.W.T. took over the River Transport Service from the Royal Indian Marine. At that date the number of vessels of all classses operating on the Tigris was 348, and the volume of tonnage carried was 2,555 weekly, or 365 tons a day.

With the assumption of full control of I.W.T. the question of suitable type of craft was thoroughly investigated, and various improvements were effected and new types introduced. The fleet in commission at 30th March, 1918, stood as follows:—

Hospital Craft (including 71 Red Cross Launches)	98
River and Harbour Tugs	141
Troop-carrying Steamers	75
Barges for River Transport and Harbour work...	532
Special Service Barges in connection with the supply of filtrated water, chilled meat, vegetables, ice and oil	64
Launches	433
Fire Floats	3
Hydro Glisseurs for despatch work	9
Total	1,355

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Further craft aggregating 146 were also in Mesopotamia under re-erection or being equipped at that date, and these, together with additional vessels under construction in India or en route from England or India, will comprise the ultimate complete fleet of over 1,700 craft.

For the week ending March 23rd, 1918, the total tonnage was 43,012, or a daily average of 6,144, with a ton mileage of 8,433,178.

It was also found necessary to make immediate and adequate provision for workshops, to deal both with the larger re-erection of craft programme and, to carry out running repairs.

The re-erection of craft despatched from England and India was undertaken at the following Stations :—

Abadan,
Mohammerah,
Mahgil (Basra),

and between September, 1916, and March, 1918, the following craft have been re-erected :—

Tugs	3
Hospital Ships	3
Refrigeration Barges	2
Cargo Barges	84

whilst the following craft, which were sent out as deck cargo or under their own power, in addition to a large number of barges, have also been fitted up for river service in these yards :—

Paddle Steamers	38
Tugs	80
Hospital Ships	12

In addition fully equipped repair shops have been established at :—

Nasiriyah,
Ezra's Tomb,
Amara,
Kut,
Baghdad,

and on an average 75 vessels pass through the aforementioned eight yards for running repairs every day.

Other I.W.T. Activities.—The question of dock and wharf accommodation was taken up, and the erection of stores and bungalows, and in practically every case sites had to be filled in to above flood level prior to the commencement of building operations. Amongst other important construction works were a wet dock basin at Mahgil capable of being used at any state of the tide, with a water area of 12½ acres and having 6,000ft. of berthing frontage; three slipways, the largest of which can take a vessel of 250ft. in length; various jetties and piers, the longest being some 230ft. in length; 1,500ft. of wharfage at Basra Dockyard and at the new port of Nahrumar, five berths each 350ft. in length, have been designed, and one is already in use. A bridge at

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Amara, 750ft. in length with a 20-ft. roadway, has also been constructed, and this, together with other bridges on the Tigris and Diala Rivers, and also maintained by the I.W.T. Large tanks for oil fuel storage are also being erected at the various river stations. In connection with the wharves and jetties 34 cranes have been supplied from England.

Buoyage and Pilotage.—With the recapture of Kut and the advance to Baghdad, the operations of the fleet were considerably extended; and important work was undertaken in the direction of establishing an efficient pilotage and buoyage organizations, involving the laying of some 600 to 700 buoys, and the erection of beacons, etc., whilst The Narrows, a very difficult stretch of the River Tigris some 15 miles in length, has been lighted by electricity, thus enabling vessels to proceed by night as well as day.

Extended Operations.—With the development of the military situation the services on the Euphrates were extended, and during December, 1917, an average of 873 tons weekly was handled in that sphere alone.

Disposition of Personnel.—I.W.T. Stations are now established at Abadan, Mohammerah, Basra, Mahgil, Kurna, Zenr, Ezra's Tomb, Qualat Saleh, Amara, Ali Cherbi, Sheik Saad, Kut, Hainaida, Azizieh, Karradah, and Baghdad, on the River Tigris.

Ahwaz, on the Karun River.

Bakub, on the River Diala.

Nasiriyah, Kufa, Killa, Hindia Barrage, Museyib, Sadiyeh, Ramadi, Madhij, Foluja, and Mupraz, on the River Euphrates.

The strength of the I.W.T., including attached and labour units, has grown steadily from 7,171 in September, 1916, to 43,906 in March, 1918.

In February, 1917, the functions of the I.W.T. were extended to include :—

(*a*) The control of the discharge of cargo at the Port of Basra with the attendant tugs and barges.

(*b*) The conservancy of the River Tigris above the Port of Basra.

As regards (*a*), the average period of detention of store ships as Basra decreased from 13.5 days in January, 1917, to an average of 6.2 in March, 1918. The weekly average of tonnage discharged in January, 1917, was 19,771, and in March, 1918, 32,397 tons. In the week ending March 8th, 36,165 tons were discharged.

As regards (*b*), energetic steps have been taken to conserve the waters of the Tigris by the construction of various weirs, dams, etc., including the repairing of the Shujair Bund, wrecked by the Turks previous to their retreat, an operation involving the excavation of 15,000 cubic metres of soil, the filling in of 44,000 cubic metres and the facing of the Bund with 25,000 sandbags, and the training of the river channels in low water by a system of bandalling.

The result of this work should be reflected in the anticipated maintenance of a 5ft. minimum channel during the low water season of 1918 (June to November), the previous draught being one of 3ft. 6in. only, with an occasional drop to 3ft.

At the moment the question of the division of such duties as affect

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the control of the Port of Basra, the management of the Ports of Basra and Nahrumar, including the discharging of cargoes, and the control of the necessary craft, plant, and labour; constructional work at ports and maintenance of wharves and piers, and the control of harbour masters, pilots, buoyage, and lighting in these ports and their allocation under two new Directorates; port control and docks, is under review.

Appendix C.

CRANES.

I.W. & D. Standard Cranes.—The variety of requisitions for cranes of ordinary and special types to meet the particular local requirements pointed to the desirability of having a special standard crane to overcome the difficulties caused by this lack of uniformity, namely :—

(1) Delay in obtaining delivery.

(2) High cost of cranes made in small number to special designs.

(3) Expense in holding stocks of spare parts for the various types and makes.

(4) Special training of men to drive the different makes of cranes, and lack of interchangeability of labour from one appliance to another.

(5) Difficulty of transferring electric cargo cranes from one port to another when circumstances necessitate it, owing to the differences in the motive power available.

(6) Low value that will be obtained at the end of the war for cranes which have been designed for a special purpose and port and cannot be removed and used elsewhere without costly alteration.

The I.W. & D. standard crane is a special design which has been prepared in detail by the Mechanical Section of the Directorate to overcome the above difficulties, and to meet as far as is possible with the minimum of alteration the varying demands from the various theatres of war.

The special feature of the design is the ability to be used as a locomotive, fixed, floating or gantry crane without alteration to the machinery, the jib and balance weight only being altered to suit the location and duty to be performed. As a locomotive crane it can be used for general purposes, for grabbing or erection work for loads up to five tons; when so arranged it will conform to the French loading gauge.

When the crane is required for dock use it can be mounted on a barge or gantry, when loads of 10 tons at 20ft. radius, five tons at 39ft. radius, or lighter loads at greater radii can be dealt with.

It is designed to give lifting speeds equal to a modern electric crane under these conditions, and is arranged so that the crane driver is placed in an equally favourable position at the front of the crane. Steam has been adopted as the motive power, as being self-contained, it is the only type of crane which can be sent anywhere without regard to local power supplies.

The attached diagram shows a few applications of the I.W. & D. standard crane.

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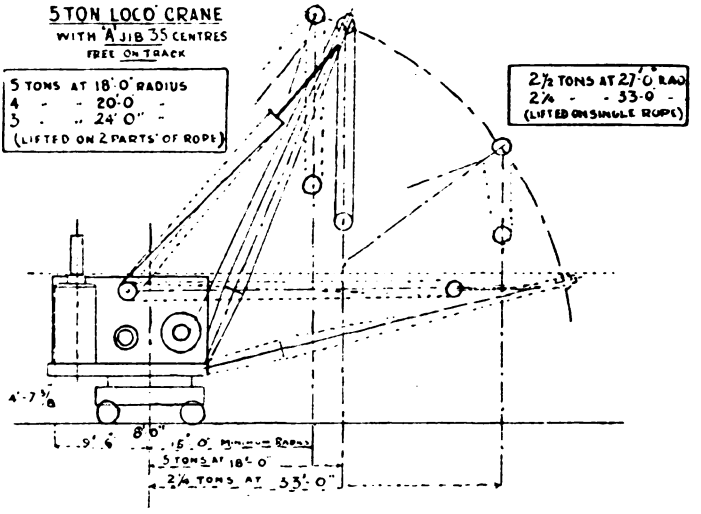

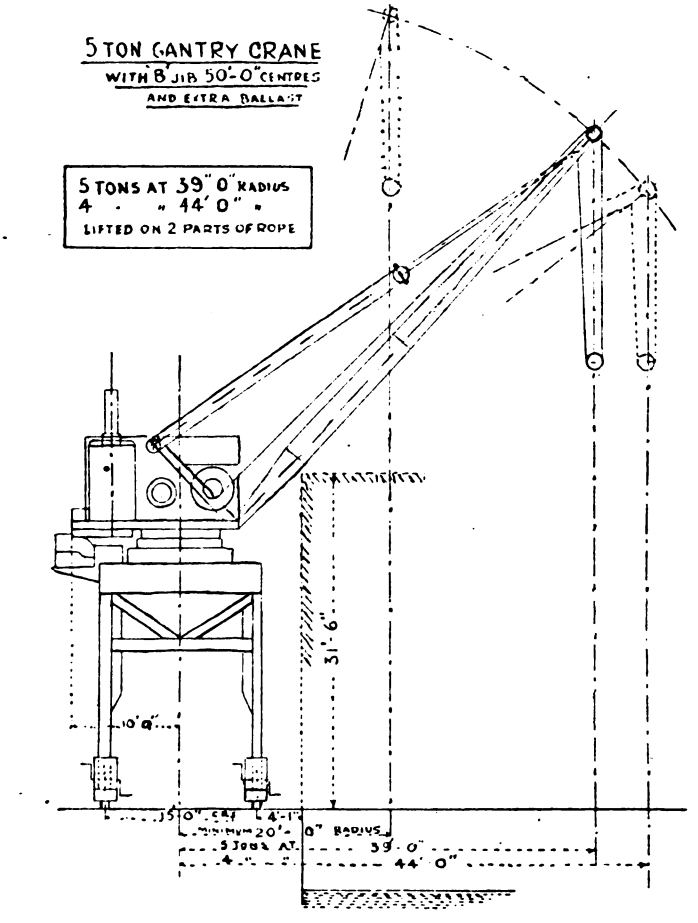

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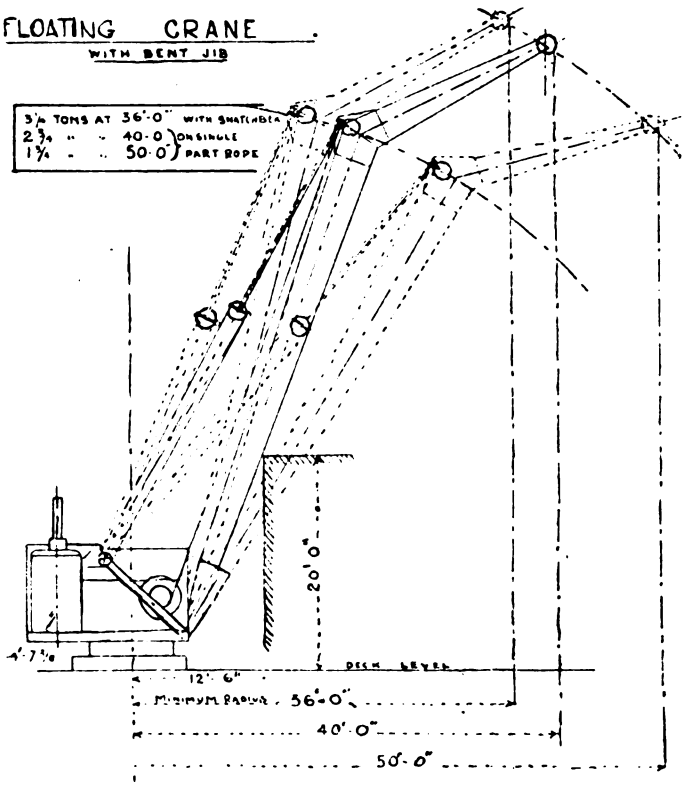

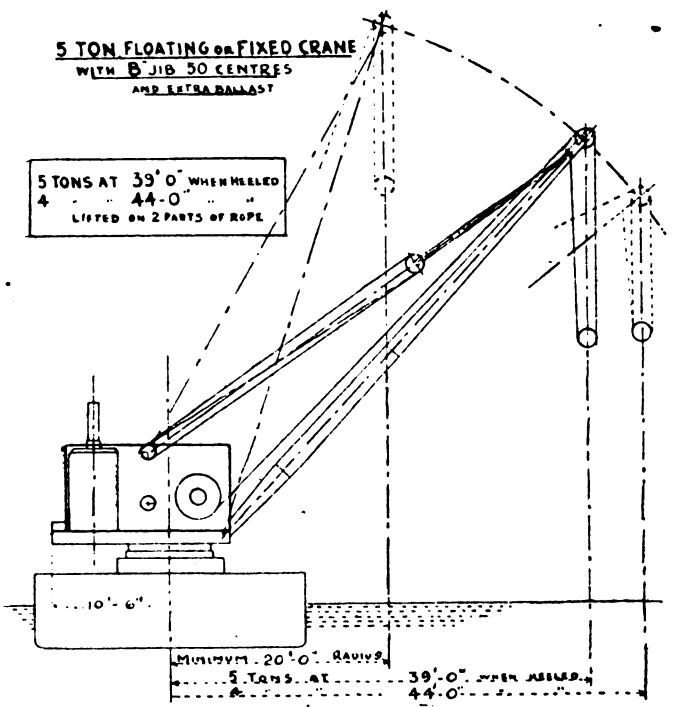
5 TON FLOATING OR FIXED CRANE
WITH B JIB 50 CENTRES
AND EXTRA BALLAST
5 TONS AT 39'-0" WHEN HEELED
4 " " 44-0" " "
LIFTED ON 2 PARTS OF ROPE
10'-6"
MINIMUM 20'-0" RADIUS
5 TONS AT 39'-0" WHEN HEELED
4 " " 44'-0"

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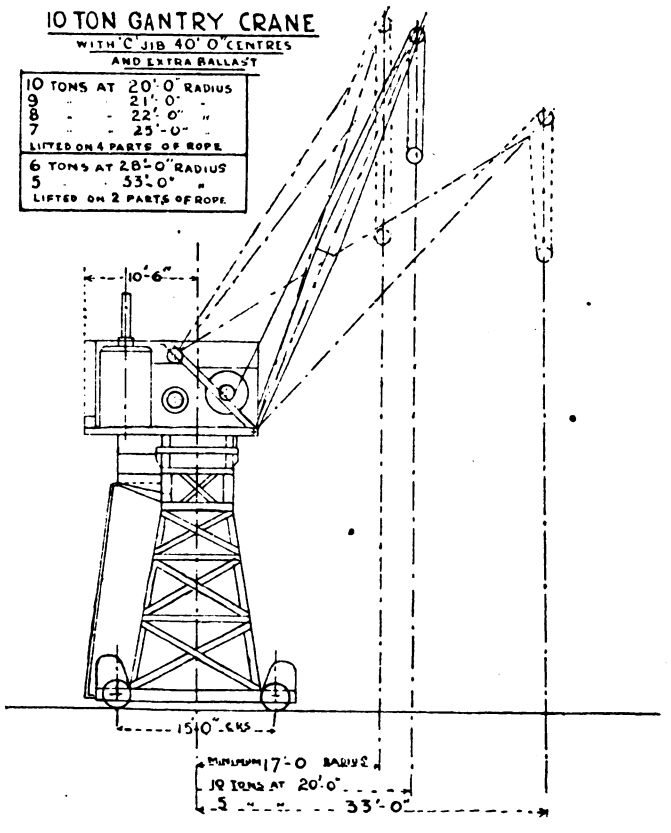
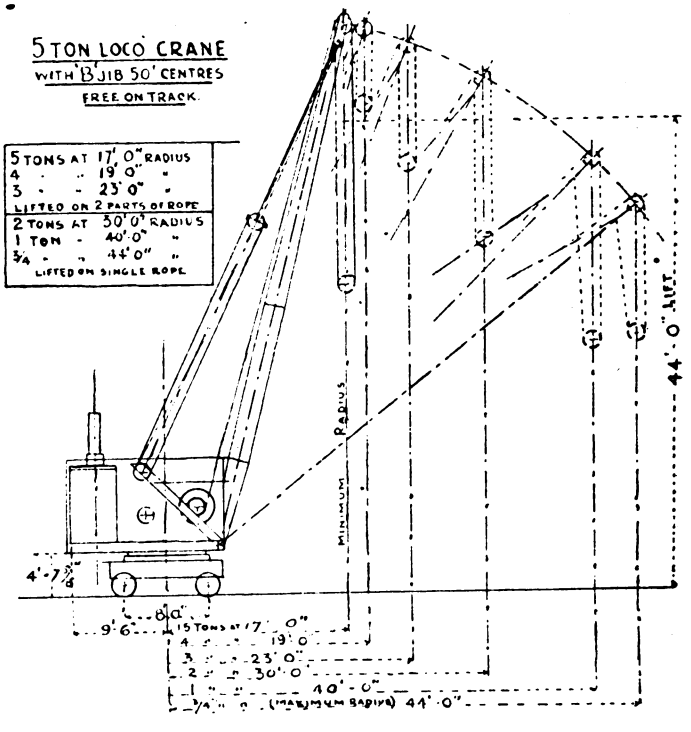

10 TON GANTRY CRANE
WITH 'C' JIB 40' 0" CENTRES
AND EXTRA BALLAST
10 TONS AT 20' 0" RADIUS
9 " " 21' 0" "
8 " " 22' 0" "
7 " " 25'-0" "
LIFTED ON 4 PARTS OF ROPE
6 TONS AT 28'-0" RADIUS
5 " 33'-0" "
LIFTED ON 2 PARTS OF ROPE
10'-6"
15'-0" C.R.S.
MINIMUM 17'-0 RADIUS
10 TONS AT 20'-0"
5 " " 33'-0"


5 TON LOCO CRANE
WITH 'B' JIB 50' CENTRES
FREE ON TRACK.
5 TONS AT 17' 0" RADIUS
4 " " 19' 0" "
3 " " 23' 0" "
LIFTED ON 2 PARTS OF ROPE
2 TONS AT 30' 0" RADIUS
1 TON " 40' 0" "
¾ " " 44' 0" "
LIFTED ON SINGLE ROPE
MINIMUM RADIUS
44' 0" LIFT
4'-7½"
9'-6"
15 TONS AT 17' 0"
4 " " 19' 0"
3 " " 23' 0"
2 " " 30' 0"
1 " " 40' 0"
¾ " " (MAXIMUM RADIUS) 44' 0"

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Cranes, other than I. W. & D. Standard Type.—In addition to the standard I. W. & D. steam cranes mentioned in Appendix "C," nearly every type of crane has been supplied to the various areas in which the B.E.F. is engaged; manufacturers' designs have been improved and brought into line as far as possible, with a view to standardization and rapid output; two standard types of electric equipment have been developed and adopted throughout, one for alternating current and one for direct current supplies.

In addition to the British Armies, cranes have been supplied to the Admiralty shipyards, the American Army in France, and a request has now been received for a supply of cranes from the French Government.

The attached schedule shows the various types of cranes which have been supplied to different Directorates and war areas.

645 CRANES DELIVERED TO ALL DESTINATIONS UP TO 30TH APRIL, 1918.

	D.I. W.T.	D DO CKS	C.E. P.C.	D G. T.	BAS-RA	EGY-PT	D.R. T.	U.S. A.	R/B-RO	A N. S.	D.C. A.S.	SUN-DRY	TO-TAL
Gantry Cranes	6	63							22				91
Loco Cranes	104	86	26	18	10	4	17	2	50	25	4	16	362
Derrick Cranes	5	4	18		2				45	9		9	92
Floating Cranes		17	1		1								19
Grab Cranes	10	2	5		1				13	2			33
Hand Cranes	12	1			20				14			1	48
	137	173	50	18	34	4	17	2	144	36	4	26	645

* This figure includes Cranes awaiting allocation, awaiting repairs and being repaired.

APPENDIX D.

Filtration Plants.—In all thirty-two of the above have been constructed. Of these twenty-four were for Mesopotamia, six for France, and two for this country. The aggregate capacity of the thirty-two plants is over four million gallons per day.

Of the Mesopotamia plants seventeen are stationary land plants and seven floating plants. The floating plants which are entirely self-contained and include officers' and crews' quarters, laboratory, store, etc., are reserved for the use of the forces in the field; the land plants, each of which is also a completely equipped unit with settling and storage tanks, and are placed at various points on the river to provide water on the lines of communication to passing ships, and to fill local requirements. For instance, one plant is placed at Marghil, another at the advance base, one at a group of hospitals north of Baghdad, two at Kutt, one on the left bank of the river at Amarah, one at Mohammerah, and one at Ahwaz.

These plants are capable of transforming the muddy Tigris water into a clear and potable supply, free of all disease germs. The plants sent out to France were all of the floating type and equipped for filtration and sterilization, and also capable of depoisoning water if required for this purpose.

These barges were referred to in one of Field-Marshal Sir Douglas

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Haig's despatches when he mentioned that they were at work on the River Lys.

The two plants constructed for this country are in connection with air stations for the R.A.F., and are for the continuous purification and sterilization of swimming bath water.

APPENDIX E.

Forage Handling Plants.—Eight pneumatic grain handling plants, each capable of discharging from 80 to 100 tons per hour, have been completed, and six plants are at work as follows :—

Calais	...	...	... 2 plants
Havre	...	...	... 2 plants
Vendroux	...	...	... 2 plants

Recently the two Calais plants discharged the s.s. *Gloire de Larinaga*, carrying 6,360 tons, in 37 working hours, *i.e.*, an average rate of discharge of approximately 170 tons per hour for the two plants.

Mechanical plants for discharging hay from barges are also being supplied to France.

In addition, a large quantity of mechanical conveyors, stacking and labour-saving devices, have been supplied to various Directorates overseas.

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CORRESPONDENCE.

FUTURE TACTICS.

To the Editor of the R.E. JOURNAL.

SIR,

With reference to General Walker's letter in the April number of the *R.E. Journal*, discussing the psychology of the British soldier and its effect on the design of defences.

Everyone will certainly agree with his final conclusion that all theories bearing on the principles of war should take into account the mentality of the troops concerned. But does the mentality of the British soldier affect the principles of the modern defensive as we have learnt them in the recent war ?

Before abandoning principles built up on sound theory and tested finally in the war, we should examine very carefully how far these principles are affected by the soldier's mental attitude.

I cannot imagine anyone wishing to go back to the defensive methods of the early part of the war. I refer to the single continuous trench line, crowded with men, with little flanking fire, no supports, no depth in the defence, no special attention paid to points of tactical importance. I believe that method, quite contrary to our pre-war regulations, grew up through our inferiority of machine guns and of artillery compared with the enemy. We were forced to crowd men up into the front line, to stop the enemy at any cost, making flesh and blood do the work which was effectively done later by mechanical means, *i.e.*, machine guns, Lewis guns, artillery.

Surely the defended locality is the framework of the defence. One cannot imagine on any stretch of country—5 miles, 10 miles, 50 miles long,—that all the ground is equally valuable to the defence; that men must be stretched out in continuous and evenly distributed lines to defend it. There must be features whose defence will enable you to dominate and to deny to the enemy intermediate ground. The spaces you can thus deny may certainly be very small in some cases and larger in others ; that depends on the ground, on obstacles, on weather, on night or day. Continuous lines of trench in the intervals are of value for communication purposes, and for concealing where you have made your defended localities.

In selecting any defensive position, the first principle is to choose ground on which all your weapons of defence may co-operate and may have the advantage over the enemy. This includes artillery, machine guns, Lewis guns, and rifles, all in their own sphere of action. Having found such a position the next step is to see which are the vital or essen-

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tial portions of it, and which are the dominating features. It is on those that the first efforts of the defence are concentrated. It is along a series of such localities that the main line of resistance is constructed. There are many further principles to satisfy, such as depth in the defence, selection of an outpost zone, etc.

Now for the question of how the individual soldier is affected.

My experience has been that the individual soldier cares little and knows less of what is happening a few hundred yards on his flank, so long as he is surrounded by his own pals, the men of his own section, and his own platoon, and has a stout platoon commander to lead him. Under those conditions he will stay where he is put or advance where he is led. He probably also takes a certain interest in the troops supporting him. Now all these conditions can be got to perfection in the defended locality designed for a company, two companies, or whatever the conditions demand. You can have two platoons in front, a platoon in support, a platoon in local reserve, or some such organization. If that company is told to fight for a certain area, their own defended locality, they will do so. The fact that the flank platoon has no men in the next fire bay will not worry the private soldier or his officers either.

I have no wish to criticize previous views on this subject, but feel it right to put forward principles in which I believe.

Yours faithfully,

P. NEAME, *Lieut.-Colonel.*

24th April, 1919.

TRANSPORT FOR R.E. FIELD UNITS.

To the Editor of the R.E. JOURNAL.

SIR,

The following observations regarding transport for R.E. field units are put forward in case they may be of interest for discussion, and are based on experience of casualties inflicted on horses by aircraft and long-range guns. These two weapons have been developed to such an extent, that latterly the provision of horse lines within reach of advanced units became a matter of considerable difficulty.

Horses are extremely difficult to conceal, and are also very vulnerable to splinters from shells or bombs. Cases occurred where a single shell, of comparatively small calibre, from a high velocity gun, knocked out 20 to 30 horses on a picket line, and the losses from bombing were sometimes very serious.

In any future operations of a similar nature to those of the past war, with large numbers of improved aircraft and guns in action, it is to be expected that such losses would be very much greater, and probably prohibitive, in the case of fighting units. These units must necessarily have their horse lines fairly close up, *i.e.*, within ten to twelve thousand yards of the front, to be able to bring up stores or ammunition, etc., without too great a strain on their animals. In consequence the conges-

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tion of horses in the zone behind the battle front of an army which is temporarily stationary, must become very great and provide a large target. It is therefore suggested that the provision of some form of motor-tractor of tank type, to draw all first line vehicles, should be considered now, with other questions affecting the reorganization of R.E. field units. A form of tractor should be practicable that would be comparatively immune from damage due to splinters from bombs or shells, which are so fatal to horses, the losses from direct hits being few in comparison to those caused by splinters.

Tractors should also produce a saving in "man power"; for example a machine driven by one man should be capable of doing the work of at least eight horses, requiring four drivers. When the numbers of men employed in the remount and veterinary camps behind the lines, required by horse-using units, are also considered, and compared with the numbers that would be necessary in corresponding mechanical workshops, a further saving in "man power" would probably be found.

If a change on a large scale to mechanical traction instead of horse traction should become necessary, it would be better to experiment and make it slowly in time of peace than to be forced to carry out the change during active operations.

The rapid advance in the fighting power of aircraft, made during the past war, is likely to continue, and make the life of the horse, who cannot take cover from splinters in a ditch or trench, more and more precarious, in any phase of warfare in the future between two nations well equipped with aircraft.

Yours faithfully,

J. A. C. PENNYCUICK, *Capt., R.E.*

6th May, 1919.

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NOTICE OF MAGAZINE.

REVUE MILITAIRE SUISSE.

No. 3.—March, 1919.

(*Continued*).

THE GERMAN AND FRENCH CAVALRIES IN THE GREAT WAR.

Colonel Poudret, the author of the original article, expresses the opinion that, if the former practice of sending officers on the instructional staff of the Swiss Army on foreign tours is revived in the future, it is to France that such officers should be sent and not to Germany as in former times. Lessons of greater value are to be learnt, it is pointed out, from the handling of the French Cavalry in the Great War than in the case of the German Cavalry.

The German cavalry at the outbreak of war took the field with 110 (active) regiments ; of these regiments 66 were formed into cavalry divisions, whilst the remaining 44 were employed as divisional cavalry. Prior to the date when Roumania came into the war, the Germans had 11 cavalry divisions in the various theatres of operations ; when Roumania joined the Entente Powers, the number of German cavalry divisions was increased to 14. Up to this time the German cavalry had played a most important rôle in the war.

The exploits of von der Marwitz's and von Richthofen's Cavalry Corps during the advance through Belgium into northern France in August and September, 1914, will be ever memorable in the annals of cavalry warfare. Later, the German cavalry played a brilliant part in the conquest of Courland.

As soon as the completion of the trench systems from the North Sea to the Swiss frontier brought the two belligerent groups to a halt in the Western Theatre, the Germans began to concentrate their cavalry in the East ; they hoped by this means rapidly to crush the Roumanian Army and to bring about the surrender of Roumania.

However, so far as purely cavalry action is concerned, the German cavalry from this time forward ceased to play a predominating rôle in the war. A deficiency in horses led to a reorganization of the German cavalry in the spring of 1917 ; and a reduction both in the number of cavalry divisions and in their establishments took place at this time. A second reorganization of the German cavalry had to be effected in

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the spring of 1918 and this led to the formation of dismounted cavalry divisions.

At the time of the great German push in March, 1918, the German Army was without any large mounted formation on the Western Front for the purpose of exploiting the successes upon which von Hindenburg was reckoning. For this reason, some have doubted the wisdom of the Great General Staff in leaving the considerable forces of cavalry in Finland, Roumania and the Ukraine, which remained there throughout the critical days of March, 1918; this cavalry would have been of immense value on the Western Front at that time.

At the outbreak of war France had ten cavalry divisions; their organization, armament and tactical training were not so up-to-date as those of the German cavalry.

The French cavalry was, however, thoroughly imbued with the spirit of offensive warfare. It made what proved to be a fruitless raid into Belgium in the early days of the war and later made its presence felt at the first Battle of the Marne. However, it was not able to carry out the essential rôle of cavalry, on any scale, in the first stages of the war.

During the period of the " Race for the Sea," it was realized that the French cavalry would have to play, in the great War, a very different part to that for which it had been maintained and trained. Therefore, in November, 1914, the French cavalry was served out with the bayonet and began to prepare itself for the new rôle it was to be called upon to play. When the days of trench warfare arrived, it took its turn of duty with other troops in manning the parapets, and in holding the enemy in check.

The French cavalry was never reduced to the same straits as was the German cavalry for want of horses. Further, the French High Command was far-seeing and kept the future well in view, so that the French cavalry continued to be trained for mounted action. Some Cuirassier Regiments were dismounted in the spring of 1916, but the men remained available for reinforcing cavalry formations.

As the war progressed the equipment and training of the French cavalry continued to be improved and brought up to date. Not only was it provided with the bayonet, as already stated, but hand and rifle grenades were also issued to it, the number of machine guns with cavalry units were increased, etc., and finally in the spring of 1918 light ' tanks ' were also attached to cavalry divisions and corps.

Colonel Poudret calls attention in the original article to the regulations relating to the employment of cavalry which were issued from the French G.H.Q. at various periods of the war, and deals at some length with the instructions of the 26th May, 1918. The instructions, last referred to, state that the training and organization of cavalry should be based on the following fundamental ideas :—" Under the conditions of present day warfare, dismounted action is the normal method of fighting for cavalry. Whenever cavalry is employed dismounted, it is essential that it should, as far as it is possible to do so, adopt the infantry organization, in order that it may thereby utilize to full ad-

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vantage the experience of the war in relation to fire-tactics, manœuvring and the maintenance of touch throughout the several parts of the fighting line."

The changes introduced in the organization of the French cavalry for the purpose of giving effect to the foregoing "Instructions" are discussed in some detail in the original article.—(*To be continued.*)

Field Railways.

The author of the original article, Capt. Raoul de Diesbach, points out that the importance of the transport services in rear of the fighting line of an army has long been recognized. Although mechanical transport can to some extent be utilised to supplement the railway communications between the forward zone and the main supply depôts of an army, nevertheless, a resort thereto is accompanied by many disadvantages, such as congestion of traffic on the roads, the heavy wear and tear of their surface, etc. For this reason, for many decades past the armies of great powers have made use of the 60-cm. gauge railway invented by Capt. Péchot. A history of this invention and some technical details in relation thereto are given in the original article.

Captain Raoul de Diesbach gives, in the original article, an extract from the issue of December 4th, 1915, of the French paper *Liberté*, wherein is described the method adopted in the German Army for the rapid construction of field railways during the early days of the war. It is said that by working three shifts of 8 hours per day, the Germans were able to construct 12 miles of light railway in 24 hours; one railway company was employed during each shift.—(*To be continued.*)

The Future of the Swiss Army.

The anonymous author of the original article deals with the question of the retention, or not, of conscription in the Armies of the world, a question which has been occupying so large a place in the discussions at the Peace Conference in Paris. He points out that the adoption by revolutionary France in 1791, and by Prussia in 1813, of the Roman doctrine, that the claim to citizenship implied in return the obligation to render military service, arose from the necessities of the moment; in each of these cases it was the question of a defensive war, the Fatherland was in danger, independence could alone be secured by reconquest. Experience teaches that personal and universal service enforced at times of great crises inevitably results, in the cases of Great Powers, in the retention of such services as a permanent institution of the State. The militarising of a people increases the risks of war, and, at the same time, renders war more inexorable and its consequences more disastrous.

The author of the original article expresses the opinion that universal military service, although regarded as a victory for democracy, as a general rule favours militarism and increases the possibility of conflicts between the Great Powers. On the other hand, he thinks that the

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small nations, since they do not usually pursue an aggressive policy, can remain faithful to the principle of compulsory military service without any danger. This principle has been an ancient tradition with the Swiss; the Confederation adopted it at its birth in 1291.

The view is expressed that Great Powers, such as Great Britain and the United States of America, which have adopted conscription for the period of the war, can well abandon it on a return to peace. The dangers which beset them having passed away, these Powers can once more revert to their former system of professional armies. Not so is it the case with the small Powers; so far as the Swiss are concerned, not only is conscription, a hereditary tradition to them, but the very existence of their country, and the safety of their people depend upon it.

The author of the original article thinks that the British Premier and Mr. Wilson in advocating the suppression of conscription have overlooked the fact that the needs of the various nations are not identical. The question whether nations are to be allowed to maintain some form of conscription, or not, is considered to be of vital importance to Switzerland from the point of view of the steps to be taken for the defence of the Republic in the future and it is urged that a study of the problem should be taken in hand by Swiss diplomats without delay.

Notes and News.

Switzerland.—The anxiety which exists in Switzerland in relation to the proposal to create a League of Nations is reflected in the repeated references which are being made to this subject in the Swiss press. It is evident that a large section of the Swiss people do not look with favour on the proposal and, indeed, fear that should a League of Nations come into existence, a situation is likely to be created which will militate against the interests of the Helvetic Republic. The Pact of Paris recalls the early conventions of the Helvetic Leagues; short extracts are given in the original notes relating to the Alliance of August 1st, 1291, of the Pact of Brunnen of December 9th, 1315, of the Charter of the Priests of October 7th, 1370, the Covenant of Sempach of July 10th, 1393 and the Covenant of Stans of December 22nd, 1481. The changes which have taken place in the general character of human society since the days of these early conventions have in no way altered the fundamental principles upon which schemes for collective defence rest.

The Swiss Federal Council appears to have been busy in preparing a scheme to secure the peace of the world. It is said to differ widely from that drafted by the Peace Conference at Paris. The Paris scheme, it is argued, attempts to create a positive military alliance for the maintenance of peace; the Berne scheme, on the other hand, binds the States of the League more loosely and distinguishes between those States which will be compelled to undertake military duties on behalf of the community at large and those that will be freed from such an obligation. The aim of the framers of the Berne scheme is to maintain the *statu quo* in Switzerland; they desire that the defence of their

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country should be left entirely in the hands of their own government as an independent matter. The Paris scheme, it is thought, would impose upon Switzerland military obligations of a different kind to that which her citizens have been accustomed and would therefore necessitate a complete reorganization of the Helvetic Army.

INFORMATION.

The Defeat of the German Army.—A note is published in relation to the article on this subject which appears in the *Revue* for February last (*vide R.E. Journal* for May). It is pointed out that the statement made by Erzberger, the German Foreign Minister, at Weimar on the 18th February last, proves clearly that the German High Command capitulated in spite of the fact that nine out of the ten conditions imposed by the victor were held to be intolerable. Would a Commander-in-Chief, it is asked, have accepted such terms had it been possible for him to extricate his army from the position in which he found it under the circumstances ?

Philately in the Swiss Army.—Philatelists may be interested to learn that during the war Swiss soldiers have been busy designing war stamps. Many of the regiments of the Swiss Army have their own special war stamps and it is said that the rarer specimens have been fetching ten francs and more. The following firms have made a speciality of this branch of philately :—E. Locher of Zurich, Zumstein et Cie. of Berne, and E. Sauer of Berne.

A short notice on Dr. Jancovici's work *La Paix de Bucarest* (Payot et Cie, Paris) appears in the *Bulletin Bibliographique* of this number of the *Revue*.

No. 4.—*April*, 1919.

MORALE AND CIVICS AS INFLUENCES IN THE TRAINING OF THE RECRUIT.

The original article consists of a lecture given by Lieut.-Colonel A. Fonjallaz to the instructional Staff of the Swiss 1st Division and is published in the *Revue* at the express request of the Inspector of Infantry of the Swiss Army.

Colonel Fonjallaz points out that the moral factors have exercised a decisive influence in the Great War. The troops of the Entente Powers have been sustained throughout their great effort to wrest the victory by their *morale*, whilst it was on brute force and in numbers that the Germans primarily placed their reliance.

The orders issued by Marshal Joffre and by the generals in command at Verdun, at Amiens and in the Champagne, during the critical days, all disclose the same fact, namely that it was the moral factors that gave the French the will to conquer and enabled them to accomplish great things.

It is pointed out that whether a man be Francophil, Germanophil,

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or strictly neutral, in every case it is admitted that had it not been for the *morale* of France, the French troops could never have made the stand they did in the early days of the German invasion.

The results obtained by the leaders of the French Army have been extraordinary, and are due entirely to the important measures taken to develop the moral qualities of the soldier during his military training. The French Army of 1915 was transformed into a most powerful instrument of war by a process in which the discipline of the heart and of character replaced the German scheme of individual training, a scheme which relies chiefly on mechanical discipline for its success.

It is urged that the most effective way to develop the moral qualities of a soldier is by establishing the closest personal contact between him and his officers, and by the latter setting him a good example. Officers can, it is pointed out, have direct and close relations with their men without jeopardizing in any way their authority; they should, it is suggested, make a point of getting to know each individual recruit, of studying his idiosyncracies, of advising him and of directing him.

Colonel Fonjallaz sets out the principles upon which each instructor should, he thinks, prepare his programme of instruction; they are as follows:—

(*a*). Lectures should be given on simple, practical and useful subjects likely to appeal to the better side of a man's nature.

(*b*). The language employed should be accommodated to the intelligence of the soldier, a sparing use should be made of notes and of abstract science.

(*c*). The soldier should be addressed familiarly and made to feel that an ordinary mortal, like himself, is speaking to him and not a superman.

Every effort should be made to provide bright and comfortable rooms for the purposes of these lectures. Environment is to education, what fertility of the soil is to the production of crops.

Another kind of moral preparation consists in officers mixing with the men on as well as off parade, and chatting with them with a view to ascertaining what is most pre-occupying their thoughts. In this way a great school is formed for character study; and officers are thereby enabled to classify those under their command according to the categories to which each man belongs.

The great thing is for officers to talk on matters which will interest the men; to tell them the history of their colours, of the campaigns in which the regiment has taken part, etc. An outline of a proposed course of lectures is given in the original article, which concludes with a short list of books likely to prove useful in the preparation of lectures.

Field Railways.

The improvements which have been made in the methods of construction of field railways, have, it is pointed out, very materially increased the mobility of troops in relation to the strategic aspects of

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warfare. On the other hand, field railways involve the use of expensive materials and the raising of a large body of highly technical troops—10 to 12 companies, *i.e.*, from 2,500 to 3,000 men, are required for the construction of 100 kilometres of field railway. About one-third of this number are required for dealing with and attending to the traffic on a similar length of line.

Some details are given in the original article of the railway troops maintained in various armies at certain periods before the outbreak of the Great War.

A brief description of the Henry portable steel bridge is also contained in the original article. There are three types of this structure, intended respectively for bridging gaps of (*a*) 6 to 33 metres ; (*b*) 33 to 40 metres ; and 40 to 54 metres. The design of the elements of the bridge is such as to permit the construction of a bridge which will simultaneously carry a load of 2 locomotives of 87 tons and 4 wagons of 15 tons. By using the Henry structure a 30-metre gap can be bridged in 32 hours.

It is pointed out in the original article that the Henry portable bridge would be exceedingly useful in the mountain regions of Switzerland, and it is suggested that the Swiss Bridging Battalions should therefore be equipped with the materials for constructing such bridges.

A New Measure of Physical Strength.

The orginal article is contributed by Dr. F. E. Koby, a Surgeon-Lieutenant in the Swiss Army. He uses the term "robusticity" to describe the physical qualities required in a soldier ; qualities summed up by him in the three words *strength, agility* and *resisting power*. It is pointed out that it is essential that medical officers engaged on recruiting duties should be able rapidly to come to a decision as to whether a man is physically fit for military service or not. Having ascertained that a man is not suffering from any malformation or disease which will disqualify him, the medical man must finally base his decision in relation to the morphological type to which the subject belongs and to measurements. The various morphological types and the question of measurements are dealt with briefly in the original article.

A formula is given by Dr. Koby to represent the "index of robusticity," whereby it is possible to classify individuals into four medical categories according to their physical development.

The Training of Troops.

The original article is from the pen of Colonel Monnier who takes exception therein to the tenour of the contributions which have been appearing in the *Revue* on the above subject. He points out that the readers of the *Revue* would imagine from the attitude taken up by the authors of the contributions in question that only since the mobilization of 1914 has any real progress been made in the training of the Swiss

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Army. To combat this view, he quotes the opinions of French officers who visited the recruits' school at Colombier, in 1913, and also those of other foreign officers who have had occasion to attend the manœuvres of the Swiss Army in the pre-war days.

The Army and Unemployment.

The sudden cessation of hostilities in November, 1918, appears to have produced a critical situation in Switzerland by throwing large numbers of men out of work. At the beginning of the war large numbers of Swiss went into foreign countries to work in munition factories; when the war ended some 60,000 of them were dismissed from their jobs and returned to their homes in Switzerland. The demobilization of the Swiss Army towards the end of 1918 aggravated the situation, which was taken advantage of by the labour agitators for their propaganda purposes.

The military authorities have come to the rescue in order to provide some relief in the cases of demobilized soldiers; regional bureaus have been opened at Geneva, Lausanne, Neuchatel, Zurich, Soleure, St. Gallen, Lucerne and Berne with the object of helping to place discharged soldiers into suitable situations. These authorities have also placed the use of barracks, bedding and other equipment at the disposal of private undertakings for the purpose of housing their men.

Notes and News.

Switzerland.—It is announced that the *Revue* will shortly publish a pamphlet entitled *La Ligue des Nations et la Neutralité de la Suisse;* Colonel Feyler is its author (price 2.50 francs).

It is stated that Swiss newspapers are advocating the raising of a Swiss Corps for active service against Bolshevists. The opinion is expressed that the employment of Swiss troops for such a purpose would in no way affect Switzerland's position as a neutral State: the existence of civilization is seriously threatened at the present time, and it is urged that the Swiss should participate in a crusade for the preservation of law and order in the world.

The *Société fédérale des officiers* is considering the question of starting a journal of its own; it is proposed to publish the articles therein both in French and also in German. This idea has been mooted on two previous occasions, but serious difficulties were met with in the attempt to produce a bilingual publication; these difficulties may, however, now be overcome.

The agitation for the appointment of officers from the "Suisse romande" to the General Staff is again in evidence; the "Affair of the Colonels" would appear to be still disturbing military society in Switzerland.

Portugal.—A special correspondence raises a protest against officers of the army intermeddling in politics. It is stated that Military Com-

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mittees, the *Juntas*, were recently formed in Portugal and were being consulted by the Government. A critical situation supervened in consequence, but apparently the Civil Power has once more established its supremacy in the State.

INFORMATION.

In a short note is described Lieut. Dagoberto Godoy's great exploit of flying over the Andes, at an altitude of 7,000 metres, in a "Bristol" monoplane. He crossed the range over "Tupungato" (6,500 metres); the journey from Santiago to Mendoza occupied 1 hour 25 minutes.

W. A. J. O'MEARA.

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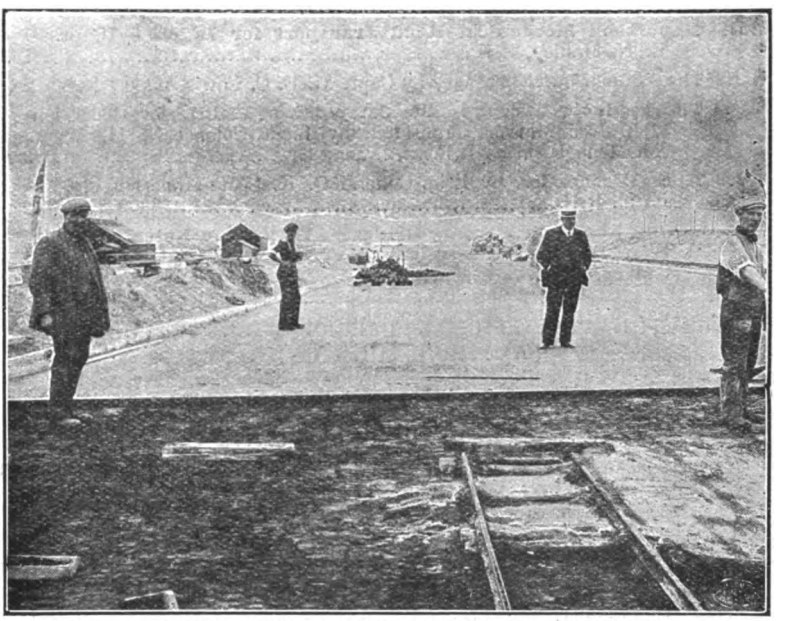

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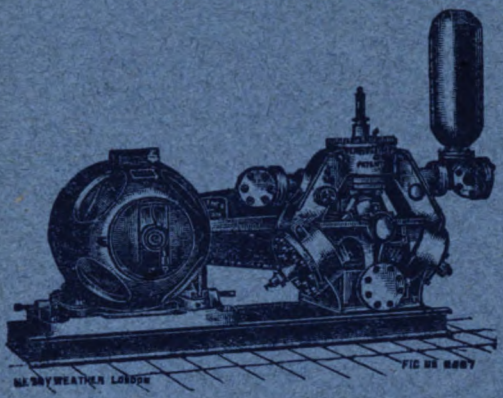

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